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CLAN ALPINE MOUNTAINS G-E-M
RESOURCES AREA
(GRA NO. NV-05)

TECHNICAL REPORT

(WSA NV 030-102)

Contract YA-554-RFP2-1054

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For

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Final Report

May 6, 1983

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EXECUTIVE SUMMARY

The Clan Alpine Geology-Energy-Minerals (GEM) Resource Area (GRA) includes the following Wilderness Study Area (WSA): NV 030-102. The GRA is located in eastern Churchill County in west-central Nevada.

The included WSA occupies much of the central portion of the Clan Alpine Mountains which structurally are typical of the Basin and Range province, and are composed of a central up-faulted core of 200 to 225 million year old sedimentary rocks surrounded and overlain by less than 60 million year old volcanic rocks.

There are three mining districts in the GRA. The Wonder district, south of the WSA, was a major silver and gold producer. The Bernice district was principally antimony and silver, and the Alpine district was tungsten, gold and silver. Antimony, tungsten and silver are all considered strategic and critical minerals.

There are abundant patented claims in the Wonder and Bernice districts. There are a few in the Bernice district which may overlap into the WSA. There are literally hundreds of unpatented mining claims in the GRA, many of which are in the WSA. Most of the claims are in close proximity to the known production of the three mining districts, but some are located outside the mining districts well within the WSA. There are roughly 240 sections under lease for oil and gas in the GRA, and 75 sections under lease for geothermal resources, mostly in the valley areas.

The entire WSA is considered to have moderate to high favorability with a low to high confidence level for metallic mineral resources based on the existing mining districts, geologic environment, claims and exploration activity. A total of ten separate classifications for metallics are outlined on the metallics Land Classification Map. There is a low favorability with a low confidence level for nonmetallics in the WSA with the exception of all the alluvium which has been rated as a moderate favorability with a moderate confidence for utilization as sand and gravel. There is low favorability with a low level of confidence for uranium and very low favorability with a very low level of confidence for thorium. The high level of leasing and continuing exploratory effort in this region, which is outside the most potential petroliferous area of Nevada, is the reason for the low to no indicated favorability ratings for oil and gas. There is a high favorability for geothermal resources immediately around an existing well, and a moderate favorability rating for similar and contiguous areas to it.

This GRA and included WSA should be further investigated to more accurately determine the true mineral potential. Such investigations would include detailed mapping, investigating existing claims, and further discussions with claimants.

I. INTRODUCTION

The Clan Alpine Mountains G-E-M Resources Area (GRA No. NV-05) contains approximately 430,000 acres (1,700 sq km) and includes the following Wilderness Study Area (WSA):

WSA Name	WSA Number
Clan Alpine Mountains	NV 030-102

The GRA is located in Nevada within the Bureau of Land Management's (BLM) Lahonton Resource Area, Carson City district. Figure 1 is an index map showing the location of the GRA. The area encompassed is near 39°30' north latitude, 117°46' west longitude and includes the following townships:

T 23 N, R 37-39 E
T 22 N, R 36-39 E
T 21 N, R 34-39 E
T 20 N, R 34-38 E
T 19 N, R 34-37 E
T 18 N, R 34-37 E

The areas of the WSA are on the following U. S. Geological Survey topographic maps:

15 minute:

Humbolt Salt Marsh
Clan Alpine Ranch
Shoshone Meadows
Edwards Creek Valley

7.5 minute:

Dixie Valley
Dixie Valley, SE
Cold Springs
Job Peak
Camp Creek Canyon
Wonder Mountain

The nearest settlement is Middlegate which is located about five miles south of the southern GRA boundary along U. S. Highway 50. Access to the area is via U. S. Highway 50 to the south and east and Dixie Valley road to the west. Access within the area is via unimproved light duty and dirt roads scattered throughout the GRA, some penetrating into the WSA.

Figure 2 outlines the boundaries of the GRA and the WSA on a topographic base at a scale of 1:250,000.

Figure 3 is a geologic map of the GRA and vicinity, also at 1:250,000. At the end of the report, following the Land Classification Maps, is a geologic time scale showing the various geologic eras, periods and epochs by name as they are used in the text, with the corresponding age in years. This is so that the

reader who is not familiar with geologic time subdivisions will have a comprehensive reference for the geochronology of events.

This GRA Report is one of fifty-five reports on the Geology-Energy-Minerals potential of Wilderness Study Areas in the Basin and Range Province, prepared for the Bureau of Land Management by the Great Basin GEM Joint Venture.

The principals of the Venture are Arthur Baker III, G. Martin Booth III, and Dennis P. Bryan. The study is principally a literature search supplemented by information provided by claim owners, other individuals with knowledge of some areas, and both specific and general experience of the authors. Brief field verification work was conducted on approximately 25 percent of the WSAs covered by the study.

The Clan Alpine Mountains GRA has been field checked and 125 stream sediment samples from this area have been collected and analyzed for twenty-nine elements. The results of this study have been reported in a separate addendum under Contract YA-553-CT2-1054 and should be included in the Clan Alpine Mountains GRA.

One original copy of background data specifically applicable to this GEM Resource Area Report has been provided to the BLM as the GRA File. In the GRA File are items such as letters from or notes on telephone conversations with claim owners in the GRA or the WSA, plots of areas of Land Classification for Mineral Resources on maps at larger scale than those that accompany this report if such were made, original compilations of mining claim distribution, any copies of journal articles or other documents that were acquired during the research, and other notes as are deemed applicable by the authors.

As a part of the contract that resulted in this report, a background document was also written: Geological Environments of Energy and Mineral Resources. A copy of this document is included in the GRA File to this GRA report. There are some geological environments that are known to be favorable for certain kinds of mineral deposits, while other environments are known to be much less favorable. In many instances conclusions as to the favorability of areas for the accumulation of mineral resources, drawn in these GRA Reports, have been influenced by the geology of the areas, regardless of whether occurrences of valuable minerals are known to be present. This document is provided to give the reader some understanding of at least the most important aspects of geological environments that were in the minds of the authors when they wrote these reports.

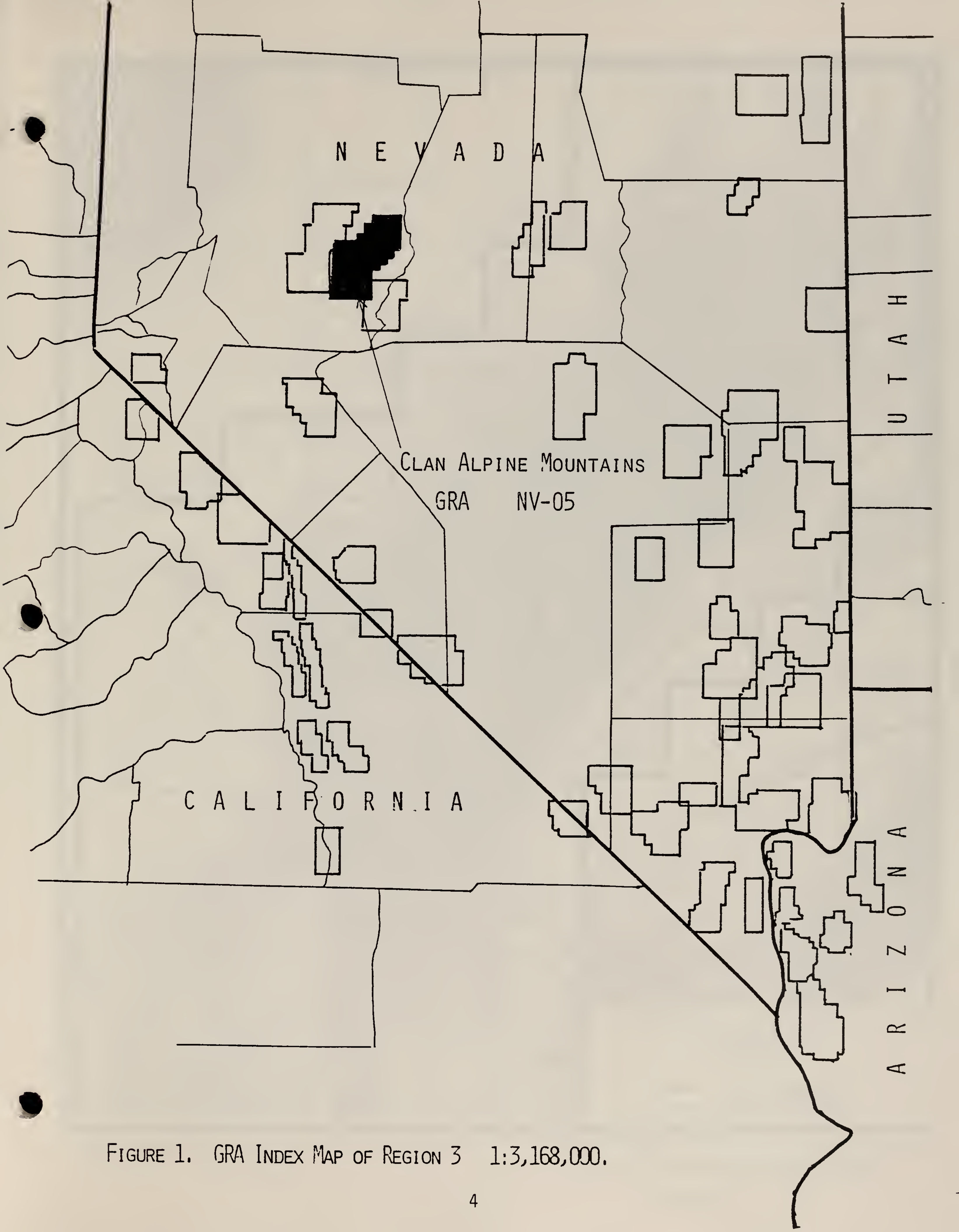
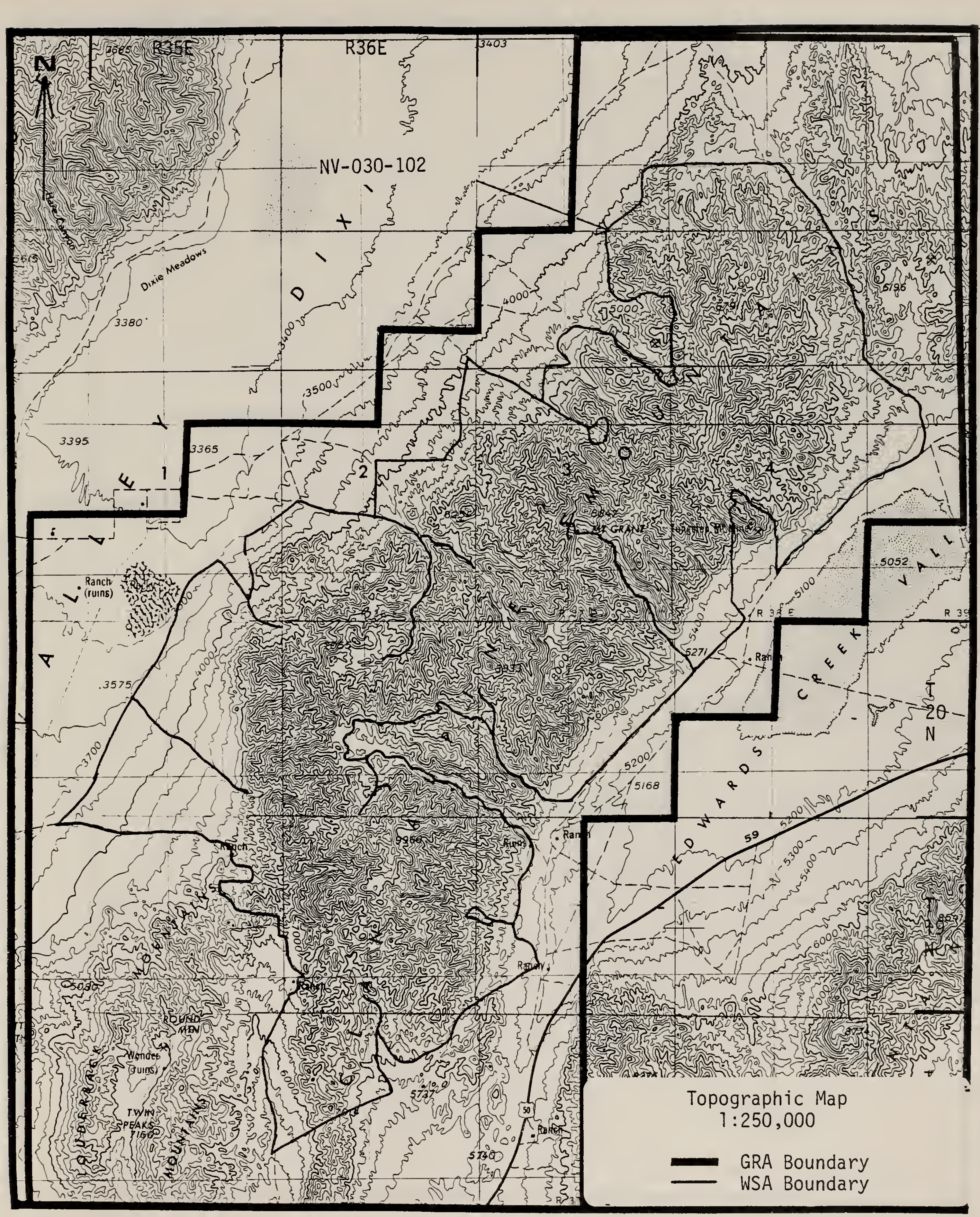


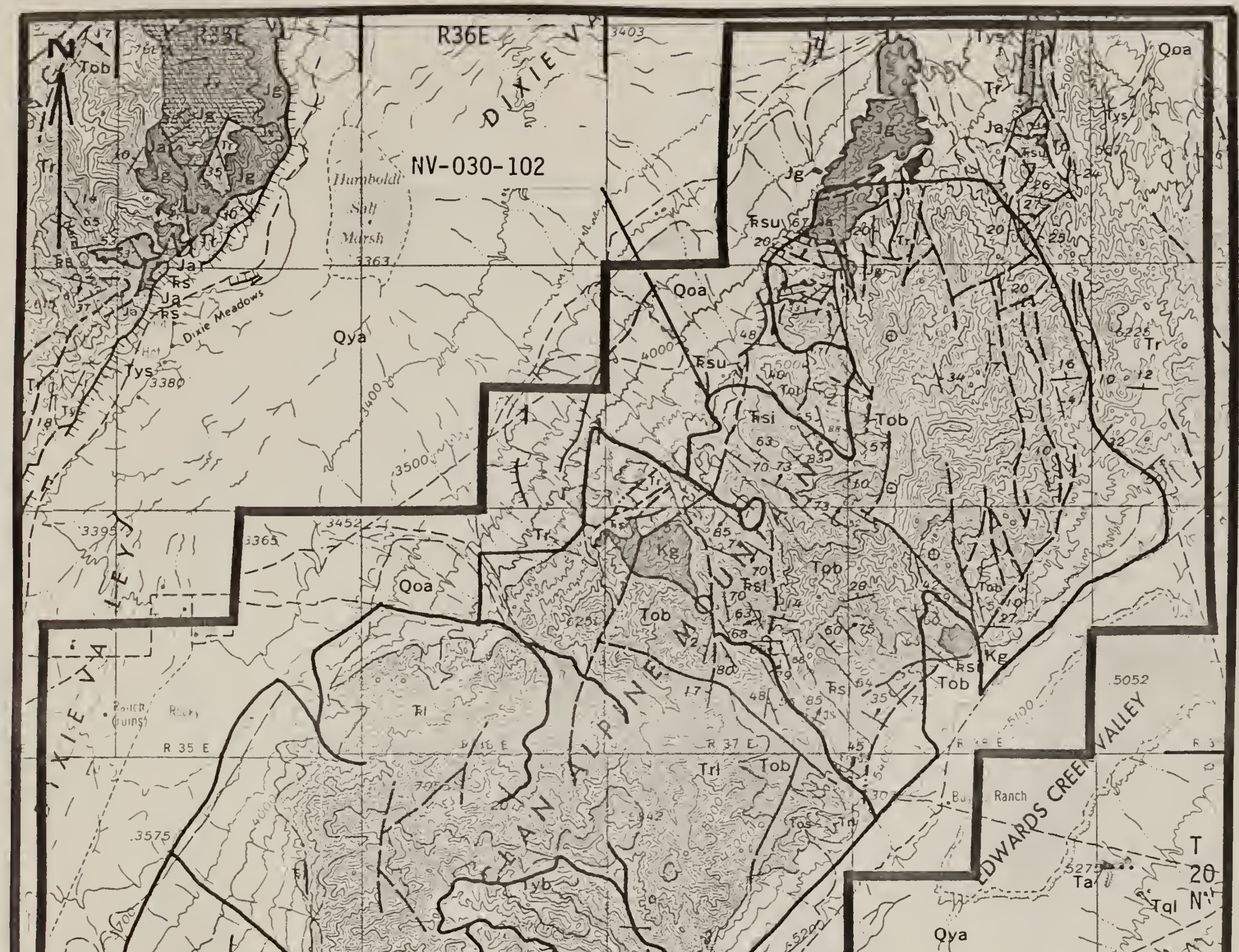
Figure 1. GRA Index Map of Region 3 1:3,168,000.



Reno and Millett Sheets

Clan Alpine Mountains GRA NV-05

Figure 2



Geologic Map
1:250,000

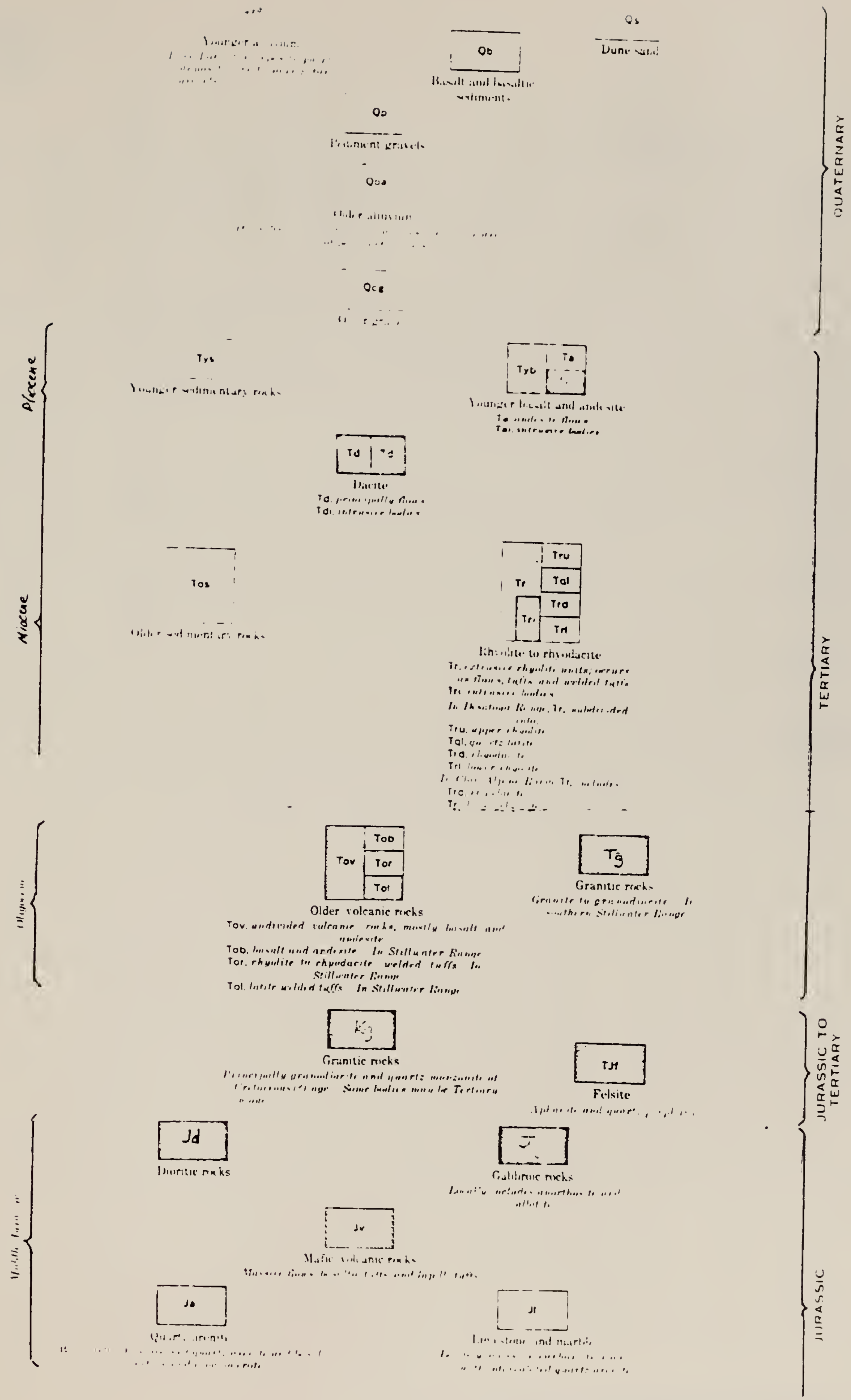
See next page for explanation

Willden and Speed (1974)

Clan Alpine Mountains GRA NV-05

Figure 3

EXPLANATION



Younger alluvium
[illegible]

Qb
Basalt and basaltic sediments

Qs
Dune sand

Qp
Pediment gravels

Qoa
Older alluvium
[illegible]

Qcg
[illegible]

Tys
Younger sedimentary rocks

Tyb Ta
Younger basalt and andesite
Ta, andesite flows
Tai, intrusive bodies

Td Tdi
Dacite
Td, principally flows
Tdi, intrusive bodies

Tos
Older sedimentary rocks

Tr Tru Tal Trd Tri Trl
Rhyolite to rhyodacite
Tr, extrusive rhyolite units; occurs as flows, tuffs and welded tuffs
Tri, intrusive bodies
In Desatoya Range, Tr, subdivided into:
Tru, upper rhyolite
Tal, quartz latite
Trd, rhyodacite
Trl, lower rhyolite
In Clan Alpine Range, Tr, includes:
Trc, [illegible]
Tr[illegible]

Tov Tob Tor Tol
Older volcanic rocks
Tov, undivided volcanic rocks, mostly basalt and andesite
Tob, basalt and andesite. In Stillwater Range
Tor, rhyolite to rhyodacite welded tuffs. In Stillwater Range
Tol, latite welded tuffs. In Stillwater Range

Tg
Granitic rocks
Granite to granodiorite. In southern Stillwater Range

Kg
Granitic rocks
Principally granodiorite and quartz monzonite of Cretaceous(?) age. Some bodies may be Tertiary in age

TJf
Felsite
Aplite and quartz [illegible]

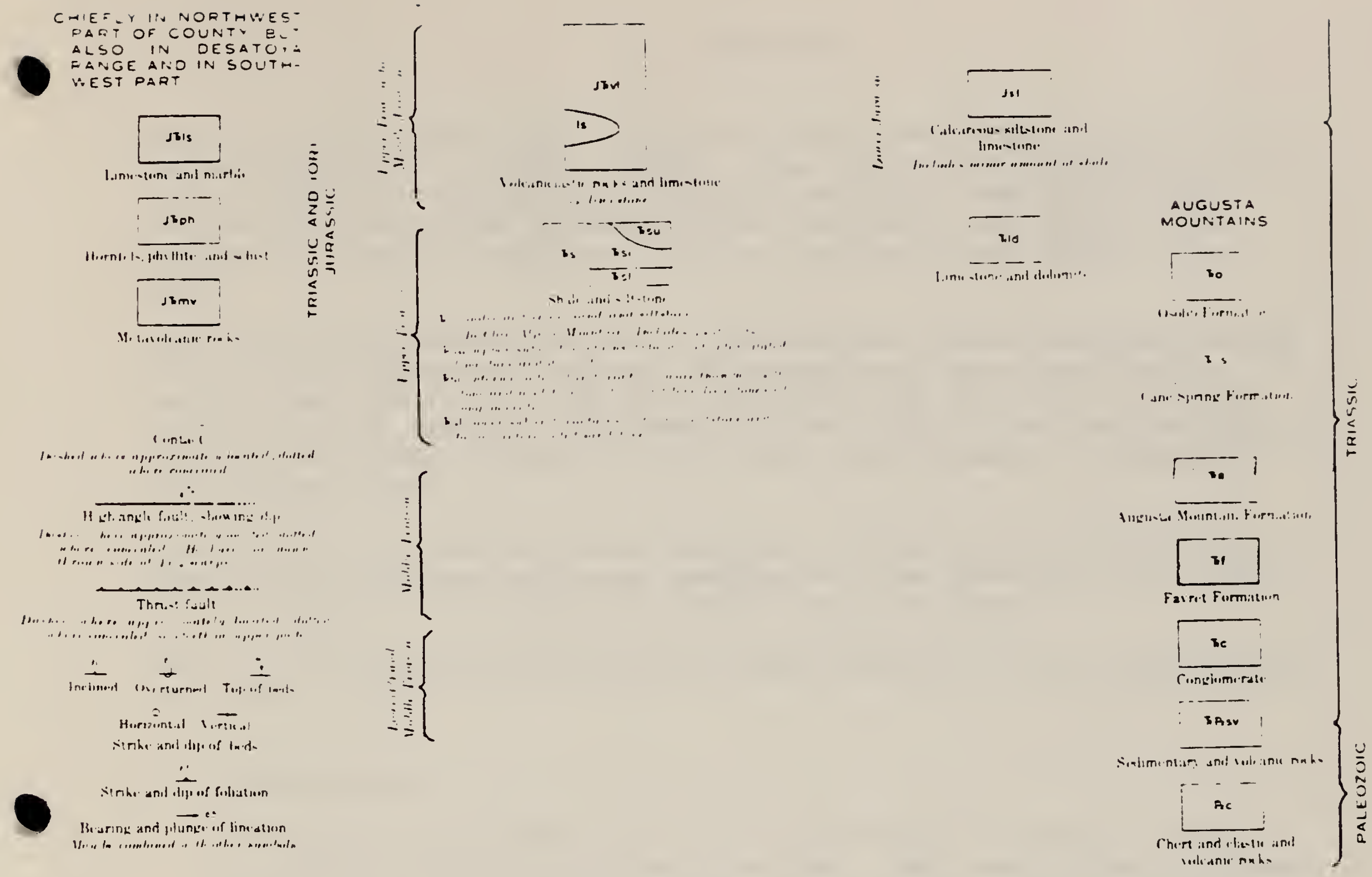
Jd
Dioritic rocks

Jg
Gabbroic rocks
Locally includes anorthosite and albitite

Jv
Mafic volcanic rocks
Massive flows, breccias, tuffs and lapilli tuffs

Ja
Quartz arenite
[illegible]

Jl
Limestone and marble
[illegible]


CHIEFLY IN NORTHWEST PART OF COUNTY BUT ALSO IN DESATOYA RANGE AND IN SOUTHWEST PART
JѢls
Limestone and marble
JѢph
Hornfels, phyllite and schist
JѢmv
Metavolcanic rocks
TRIASSIC AND (OR) JURASSIC
Contact
Dashed where approximately located; dotted where concealed
High angle fault, showing dip
Thrust fault
Inclined
Overturned
Top of beds
Horizontal
Vertical
Strike and dip of beds
Strike and dip of foliation
Bearing and plunge of lineation
JѢvl
ls
Volcaniclastic rocks and limestone
Ѣsu
Ѣs
Ѣsl
Shale and siltstone
Jsl
Calcareous siltstone and limestone
Ѣld
Limestone and dolomite
AUGUSTA MOUNTAINS
Ѣo
Osobb Formation
Ѣs
Cane Spring Formation
Ѣa
Augusta Mountain Formation
Ѣf
Favret Formation
Ѣc
Conglomerate
ѢPsv
Sedimentary and volcanic rocks
Pc
Chert and clastic and volcanic rocks
TRIASSIC
PALEOZOIC

II. GEOLOGY

The Clan Alpine GRA lies within the Basin and Range province in eastern Churchill County, Nevada. The study area includes most of the northeast-trending Clan Alpine Mountains. WSA NV 030-102 covers the range from Shoshone Creek Canyon in the north to a northwest-trending boundary line in the south near Bench Creek Ranch.

The Clan Alpine Mountains are a fault-bound block composed mainly of Tertiary volcanics ranging in composition from rhyolite to basalt (see Figure 3). An upthrown block in the center of the range contains Mesozoic sediments which reflect the two periods of folding and minor thrusting which occurred between mid-Jurassic and Miocene time.

Granodiorite intrusive bodies emplaced during the Cretaceous(?) crop out on the east and west margins of the upthrown block, and may be cupolas of a larger intrusive body at depth.

Most of the following geological description is taken from Wilden and Speed, 1974.

1. PHYSIOGRAPHY

The Clan Alpine GRA lies within the Basin and Range province in eastern Churchill County, Nevada. The study area includes most of the Clan Alpine Mountains which trend north-northeast from their southernmost point at Westgate on U. S. Highway 50 to their intersection on the north with the Augusta and New Pass Mountains.

The present physiography of the range is a result of block faulting which initiated in Late Tertiary and continues into recent history. Major earthquakes of magnitudes greater than seven occurred in 1954 resulting in recent faulting in Fairview and Dixie Valleys along the west side of the range. Tertiary volcanics cover much of the GRA. Rhyolite is the predominant rock unit in the northern and southernmost parts of the range, and rhyodacite and an older rhyolite sequence are predominant in the south-central part. Mosozoic sediments, Jurassic gabbro and volcanic sedimentary rocks are exposed mostly in a central uplifted fault block, with Cretaceous(?) age plutons exposed on the east and west flanks of this horst block.

Elevations along the crest of the range average over 7,000 feet with the highest point of 9,966 feet at Mount Augusta. Dixie Valley, adjacent to the west, averages about 3,500 feet, and Edwards Creek Valley on the east averages about 5,200 feet. Drainage of the range is internal with seasonal discharge of streams flowing into adjacent valleys.

2. ROCK UNITS

The oldest rock unit exposed is a thick widespread sequence of unnamed Triassic siltstone and shale which crops out in an upthrown block in the central part of the range. These sediments are progressively younger toward the north. The total estimated unit thickness of 20,000 feet may be due to repetition by folding and intraformational thrusting.

Several outcrops of the eastern edge of the Late Jurassic Humboldt gabbroic lopolith occur in the northwest part of the GRA. Rock types contained in this formation include picrite, olivine gabbro, hornblende gabbro and anorthosite.

Cretaceous(?) granodiorite bodies within the mid-range upthrown block, crop out on the east and west flanks of the Clan Alpine Mountains and are the next youngest formation. Basalt and andesite were deposited in the same vicinity during the Early Tertiary.

Tertiary volcanics ranging in composition from rhyolite to rhyodacite cover a major portion of the north and south areas of the GRA. In the northern part accumulations of rhyolite ash flows may be as thick as 2,000 feet. South of the Shoshone drainage the section wedges out. South of Crescent Canyon the ignimbrites are underlain by a unit of locally thick massive rhyolite and latite flows and are overlain by rhyodacite welded tuffs and flow units.

Sediments deposited contemporaneously with the Tertiary volcanics crop out in the southeast corner of the study area. The most abundant rock type in this unit is a pebbly conglomerate which weathers to produce badlands topography. Also interlayered with mudstones are diatomaceous shale, diatomite, tuffaceous shale and some well-sorted sandstone.

The next youngest rock unit is a Pliocene basalt that rests unconformably on most of the older rocks. This formation crops out north of Cherry Creek along the range crest, on the eastern range front near the Clan Alpine Ranch, and along the western range front of the central upthrown fault block. Deposited at the same time as the basalt are thick accumulations of lacustrine and fluviatile sediments. They are similar in gross lithology to the previously described Miocene sedimentary unit, however, the Miocene section lacks limestone, and the diatomite in the Pliocene section occurs in much thicker beds. This formation occurs in the northernmost portion of the GRA, but well outside the WSA boundary.

3. STRUCTURAL GEOLOGY AND TECTONICS

The oldest structural features preserved in the Clan Alpine GRA are found in the Mesozoic sediments in the central portion of the GRA. Two periods of deformation folded the Triassic

siltstone. The earlier folds, formed during Middle Jurassic time, have a wide spread wavelength with axial traces that are predominantly westerly to northwesterly. The entire siltstone outcrop in the Clan Alpine Mountains is believed by Willden and Speed (1974) to be the north flank of an anticline. Associated folds often have wavelengths of less than several thousand feet. The second phase of folding, which occurred sometime between Middle Jurassic and Miocene time, has a wavelength of at least a mile and there are a few associated minor faults.

A number of small thrust faults occur in the upper sub-unit of the Triassic siltstone which may have originated as gravity slides into troughs created by folding during the first phase of folding (Willden and Speed, 1974).

An upper thrust plate of gabbro and quartz arenite near Shoshone Springs has overridden folded autochthonous quartz arenite. The thrust was emplaced during the crystallization of the igneous rocks which have been radiometrically dated as Middle Jurassic (Speed and Page, 1964).

Basin and Range-type normal faulting has formed much of the present day topography. The west flank of the range may descend gradually by Holocene step faults of relatively small displacement (Willden and Speed, 1974). Numerous northwest-trending faults have transected the Miocene age volcanics in the area, indicating that the faults are post-Miocene. The faults bounding the central upthrown block cut the Oligocene older basalt unit and therefore are younger.

Faulting in the Dixie Valley area in 1954 creating major earthquakes reactivated older faults or created new ones along the western range front of the Clan Alpine Mountains.

4. PALEONTOLOGY

The dominant lithology of the Clan Alpine Mountains GRA is that of welded silicic ash flow tuffs with local air fall ash units and thin interbeds of Tertiary lacustrine and fluviatile sediments. No fossil localities are known to have been recorded from this GRA, and from field observations by this author, there appears to be no occurrence of paleontological resources within the area. However, approximately four miles north of the area of concern, skull and pelvic elements of Mammuthus Columbi were collected by the author and personnel of the Nevada State Museum (1968) from Quaternary alluvium. It is common for Pleistocene strata containing mammalian remains to have several occurrences over a wide area at the same stratigraphic level, and therefore it would not be unusual to find mammals in Quaternary units within the GRA boundaries.

5. GEOLOGIC HISTORY

Highlands formed during the Permian Sonoma orogeny possibly provided the clastic material that makes up the oldest rock unit found in the Clan Alpine GRA -- an unnamed Triassic siltstone and shale unit. This siltstone was folded and locally thrusted during two episodes of deformation. The first occurred sometime during the Middle Jurassic and the other in post-Middle Jurassic to Miocene time.

Gabbro was intruded during the Late Jurassic and caused local thrusting.

During the Cretaceous(?) granodiorite bodies were emplaced in the central portion of the range. This region was widely metamorphosed to low-grade hornfels, indicating that the exposed bodies may be cupolas of a more extensive pluton at shallow depth (Willden and Speed, 1974).

Volcanism began in Early Tertiary time and continued intermittently through the Pliocene. Basin and Range faulting possibly began during mid-Tertiary and continues to be active in recent times as is evidenced by new scarp formation during major earthquakes in 1954.

III. ENERGY AND MINERAL RESOURCES

A. METALLIC MINERAL RESOURCES

1. Known Mineral Deposits

The Alpine, Bernice and Wonder districts are located within the boundaries of the Clan Alpine Mountains GRA and are shown on the Mineral Occurrence Map.

The Alpine district covers a large area on the east flank of the range from the silver deposits in Florence Canyon on the south to the Nevada Gold group about 20 miles to the northeast (Willden and Speed, 1974).

The Florence Canyon area (#1) contains several mines and prospects that were described by Schrader (1947). Very minor amounts of gold and silver were produced from quartz veins and silicified shear zones in rhyodacite and quartz latite.

Gold production in the Alpine district has also come from the Nevada Gold group (#2) about two miles northwest of the Tungsten Mountain mine. This property was active in 1939 when it was visited and described by Vanderburg (1940). This mine produced almost all of the 52 ounces of gold and 1,940 ounces of silver reported as the total production of precious metals for the Alpine district. The district is also credited with the production of 193 tons of lead which also came mainly from the Nevada Gold group (Willden and Speed, 1974). The Nevada Gold group has been developed by several adits that are now inaccessible. Mineralization occurs in a quartz-calcite vein one to two feet wide, that runs along the hangingwall side of a fine-grained granodiorite dike that cuts phyllite country rocks (Willden and Speed, 1974).

The Tungsten Mountain mine (#3) was active between 1954 and 1961 (Davis and others, 1962). The ore occurs as scheelite in tactite developed along a contact between upper Triassic siltstones, quartzite and limestone country rocks and granodiorite. The mine is developed by open cuts, adits on four levels and underground shafts connecting the levels. Past production figures and remaining ore reserves for this property are unknown at this time.

The Bernice district is on the west side of the Clan Alpine Mountains in the northern part of the GRA. The largest mines in the district are in the Hoyt Canyon and Bernice Canyon areas. Silver was discovered in the late 1870s and $155,679 was recorded as the production between 1883 and 1890 (Couch and Carpenter, 1943).

Silver was produced from the Bernice (#4) and Hoyt (#5) mines. The Bernice mine is developed by three levels that explore a northerly-trending quartz vein in phyllite and slate. The Hoyt mine has produced about $60,000 in silver and 13 tons of antimony metal. The property is developed by four adits that explore quartz veins in sandstone, shale and limestone.

Antimony was discovered in the district in the 1880s and was produced in 1893, 1906, 1916, and in the early 1940s (Lawrence, 1963). The Antimony King mine (#6) has been active up to the present. A total of about 300 tons of antimony has been produced from the district. The Antimony King mine was mapped and described by Lawrence (1963). The property is developed by three adits with stopes developed off the adits. Several trenches explore the quartz veins at the surface. The main vein roughly parallels a highly fractured and brecciated sill, and varies from a few inches to about four feet in width. The main ore mineral is stibnite with some arsenopyrite, pyrite and sphalerite. Other mines in the district that have produced less than 50 tons of antimony metal are: the Drumm mine, the I.H.X. mine, and the Lofthouse mine.

Mercury in the Bernice district has been extracted from the Red Bird mine (#7), located about 10 miles to the northeast from the main part of the district and north of the WSA boundary. A reported 49 flasks of mercury has been produced from cinnabar-bearing veins in limestone and siltstone (Willden and Speed, 1974).

The Wonder district was visited and described by Schrader (1947). About 74,000 ounces of gold and 6.87 million ounces of silver have been extracted chiefly from quartz adularia veins that occur in fissures and shear zones in quartz latite to rhyolite extrusives. The Nevada Wonder mine was the largest mine in the district, and is developed to a depth of more than 2,000 feet by means of two vertical shafts and various subshafts and winzes. The Wonder district is by far the most important in the GRA, but it is approximately three miles outside the southwestern boundary of the WSA.

2. Known Prospects, Mineral Occurrences and Mineralized Areas

The majority of metallic prospects and occurrences in the Clan Alpine Mountains occur within or in close proximity to the known mining districts. In addition, weak geochemical anomalies have been determined from the analysis of 125 stream sediments samples collected from the GRA and discussed in a separate report under contract #YA-553-CT2-1054. Known mining districts such as Florence Canyon, Tungsten Mountain, and Bernice were geochemically

anomalous in elements related to the type of mineralization found in each respective area.

The Cow Canyon area is weakly anomalous in copper with two samples anomalous in antimony or zinc. The Bench Creek Ranch area is also weakly anomalous in copper.

The Florence Canyon area (#1), included by Willden and Speed (1974) in the Alpine district, contains several silver prospects. Steeply-dipping quartz veins and mineralized shear zones have been prospected by numerous shallow pits and adits. Willden and Speed (1974) report that they had difficulty in locating the mines and prospects in the Florence Canyon area as described by Schrader (1947), since they were not located on topographic maps of the area. MILS data has identified the following prospects as being located in this area (Sec. 19, T 19 N, R 37 E): Williams, Windlass, Healy, and an unknown silver prospect.

The Scott prospect, located at the foot of Granite Point about four miles north of Buyers Ranch, explored a shale-granite contact that reportedly contained good values in gold.

According to Don Koza, owner of the Tungsten Mountain property, flat lying quartz veins containing precious metals occur in an area southwest of Tungsten Mountain. Specific research or published information concerning those prospects is not available and it is suggested that this area be assessed for its mineral potential.

The Crescent Canyon tungsten prospect (#8) is located on the west slope of Mount Grant, and is included by Willden and Speed (1974) in the Alpine district. The property is developed by two short adits that explore a scarn zone in limestone near a contact with a dacite plug.

Prospects in the Bernice district are located predominantly in Bernice Canyon in the vicinity of #4 and #6 on the Mineral Occurrence Map. The Arrance prospect, Blue Eagle group, Marguerite group, Last Hope prospect, Spring Creek prospect and Far South Marguerite group are all located in this area and contain varying amounts of antimony mineralization, usually in the form of stibnite in pods, and single crystals and veinlets in narrow quartz veins. Felsite dikes are associated with the mineralization in several localities.

Prospects in the Wonder district are numerous and often follow northwest-trending quartz veins predominantly in Tertiary rhyolite. Prospects occur within about a 10 mile by seven mile area with Camelback Peak at the center. Very few of these diggings produced any precious metals and the Nevada Wonder mine is the only deposit in the area

with significant past production.

3. Mining Claims

Mining claims are generally located in the mining districts described in the previous section and are shown on the Claim Map. Patented claims are located in seven sections in the Bernice district, and 16 sections in the Wonder district. The only patented claims which fall within the WSA are located in Secs. 18 and 19 of T 22 N, R 38 E in the Bernice district.

Unpatented claims in the Alpine district occur mainly in the Florence Canyon area and near the Tungsten Mountain mine.

Several scattered claims are located by private individuals in Sec. 30, T 20 N, R 37 E and in the Mount Grant area, and the next township north. The Southland Royalty Company has a large unpatented claim block along the northwest flank of the range and numerous claims in the Bernice district.

Houston International has about 50 claims located in the SE 1/4 of T 21 N, R 36 E.

It should be noted that claims listed on the microfiche in T 20 N, R 36 E in the SW 1/4 are mislocated. This claim group is located in T 2 N, R 36 E (Personal Communication with Mr. Gary Allen of Minerals Management Ltd., January 26, 1983).

The FX claims in section 22 of T 21 N, R 38 E were located by Don Koza for their precious metal potential. Numerous flat lying quartz veins reportedly occur in this area.

4. Mineral Deposit Types

Mineral deposit types that occur within the Clan Alpine GRA are metal-bearing epithermal vein deposits and contact metamorphic skarn deposits.

Narrow epithermal quartz veins in the Florence Canyon area of the Alpine district were historically developed for their silver and gold values. These veins occur along shear zones in rhyodacite and quartz latite. The ore minerals are chiefly cerargyrite, argentite and gold (Schrader, 1947). The Nevada Gold group in the northern end of the district produced gold, silver and lead from a one- to two-foot thick quartz-calcite vein on the hanging wall side of a fine-grained granodiorite dike that intrudes green and greenish-gray phyllite. The dike and vein strike N 5° W and dip 48° west. Vanderburg (1940)

reported that the economic minerals are silver, gold, tetrahedrite, sphalerite, and pyrite.

Flat-lying quartz veins in the Tungsten Mountain area reportedly carry low to moderate precious metal values (Koza, 1983). No specific research data concerning these deposits is available.

The Tungsten Mountain mine has developed a scheelite-bearing tactite occurring of a granodiorite-Upper Triassic siltstone contact. The granodiorite, emplaced during Late Cretaceous-Early Tertiary time, was the source for the mineralizing fluids.

The Bernice district produced silver and antimony from quartz veins in Triassic sedimentary rocks. Ore often occurs as pods of stibnite associated with arsenopyrite, pyrite and sphalerite. The Red Bird mine at the north end of the district produced about 49 flasks of mercury from cinnabar in fractures in the uppermost level of the lower-plate rocks exposed in a local undulation of a thrust (Willden and Speed, 1974). This area and the area one half mile to the southwest have been recently heavily prospected possibly for disseminated gold deposits according to Lyle Campbell (1983), and such deposits can be expected to be the principal targets for gold prospections throughout the GRA.

In the Wonder district almost all the production has come from the Nevada Wonder mine which developed precious and base metal-bearing quartz-adularia veins that cut Tertiary volcanics. The siliceous veins occur in fissures and shear zones largely in quartz latite to rhyolite intrusives. The veins range from less than a foot to over 40 feet in width and are usually separated from the wall rock by a tabular sheet of gouge. The Nevada Wonder vein was worked to a depth of more than 2,000 feet and contained oxidized ore to the depth of 1,300 feet, which seems to mark an old ground water table. The values occur mostly in the hangingwall side of the vein. Auriferous argentite, free gold, angentite, cerargyrite and halogen salts are the principal ore minerals.

5. Mineral Economics

The past production of precious and base metals, tungsten, mercury, and antimony has come from underground deposits that would be very costly to develop under current economic conditions. This would probably preclude the interest of large mining companies in these deposits. However, the geologic setting and the presence of mercury and antimony mineralization are favorable indicators for other types of deposits, such as Carlin-type gold deposits that may occur in the area.

In essence the large scale production of minerals from presently known depostis in this area does not appear to be favorable due to the narrowness of the veins requiring expensive underground development. However, there is good exploration potential for types of deposits which would be amenable to open-pit mining.

More than half of all tungsten used is in the form of tungsten carbide, a hard and durable material used in cutting tools, wear-resistant surfaces and hard-faced welding rods. Lesser quantities are used in alloy steels in light bulb filaments and in chemicals. World production of tungsten is nearly 100 million pounds annually, of which the United States produces somewhat more than six million pounds, while using more than 23 million pounds. The shortfall is imported from Canada, Bolivia, Thailand and Mainland China, as well as other countries. Tungsten is a strategic and critical metal. United States demand is projected to about double by the year 2000, and most of the additional supply will probably be imported, because large reserves are in countries in which profitability is not a factor -- they need foreign exchange, and therefore sell at a price that few domestic mines can match. Tungsten prices F.O.B. mine are quoted for "short ton units", which are the equivalent of 20 pounds of contained tungsten. At the end of 1982 the price of tungsten was about $80 per short ton unit.

The principal use for mercury is in the manufacture of alkalies and chlorine, in which the mercury does not become a part of the final product, but is used as an electrical conductor and a sealant. Thus it theoretically is not consumed, but in fact some is lost during the process so some renewal is constantly required. The start-up of a single alkali- or chlorine-producing plant calls for very large quantities of mercury for the initial installation. Electrical applications, including mercury batteries, lamps, rectifiers and switches account for nearly one-third of consumption; and paints, agricultural chemicals and dental amalgam require substantial quantities. Mercury is measured in units of flasks, one flask being 76 pounds of mercury. The United States consumes nearly 50,000 flasks per year and produces about one-half this much -- most of it from the McDermitt mine in northwestern Nevada. The principal world producers are Italy, U.S.S.R., Spain, Algeria and China. Italy and Spain are considered to control the world market because their deposits are large and rich. Numerous mines in the western United States, most of them small, have produced mercury in the past, but in general they cannot compete on the world maket today. Mercury is listed as a strategic metal. United States demand for mercury is forecast to remain at about its present level to the year 2000 (principally because toxic effects of the metal discourage uses in any but the most essential applications), while

domestic production is expected to drop to essentially zero when the McDermitt deposit is exhausted. The price for mercury at the end of 1982 was $360 per flask.

Nearly half of all antimony is used as an alloying constituent of lead and other metals. In this application the largest part goes into the lead plates of automobile and other batteries, but much is used in cable sheaths, tank linings, typemetal, solder and ammunition. In chemical combination with other elements it is used as a flame retardant, in rubber and plastic products and ceramics. The United States uses about 50,000 short tons annually, but produces only about 1,000 tons, and nearly all of that as a byproduct of the treatment of other metals -- principally silver from the Coeur d'Alene district of Idaho. The principal world producers are China, the Republic of South Africa and the U.S.S.R. Antimony is listed as a strategic and critical metal. By the year 2000 United States antimony consumption is forecast to increase by about one half over the present consumption, while domestic production remains about the same. The price of antimony at the end of 1982 was 95 cents per pound.

The major uses of silver are in photographic film, sterlingware, and increasingly in electrical contacts and conductors. It is also widely used for the storage of wealth in the form of jewelry, "coins" or bullion. Like gold it is commonly measured in troy ounces, which weigh 31.1 grand grams, twelve of which make one troy pound. World production is about 350 million ounces per year, of which the United States produces about one-tenth, while it uses more than one-third of world production. About two-thirds of all silver is produced as a byproduct in the mining of other metals, so the supply cannot readily adjust to demand. It is a strategic metal. Demand is expected to increase in the next decades because of growing industrial use. At the end of 1982 the price of silver was $11.70 per ounce.

The major use of gold is for storing wealth. It is no longer used for coinage because of monetary problems, but many gold "coins" are struck each year for sale simply as known quantities of gold that the buyer can keep or dispose of relatively easily. The greatest other use of gold is in jewelry, another form of stored wealth. In recent years industrial applications have become increasingly important, especially as a conductor in electronic instrumentation. In the United Stated and some other countries gold is measured in troy ounces that weigh 31.1 grams -- twelve of which make one troy pound. Annual world production is about 40 million ounces per year, of which the United States produces somewhat more than one million ounces, less than one-fourth of its consumption, while the Republic of South Africa is by far the largest

producer at more than 20 million ounces per year. World production is expected to increase through the 1980s. For many years the price was fixed by the United States at $35 per ounce, but after deregulation the price rose to a high of more than $800 per ounce and then dropped to the neighborhood of $400 per ounce. At the end of 1982 the price was $460.50 per ounce.

The largest use for lead is in electrical storage batteries, the second being a gasoline antiknock additive. It has many other uses, however, including radiation shielding, solders, numerous chemical applications and in construction. About four million metric tons of lead are produced in the world annually. The United States produces about half a million tons per year, and recovers about the same amount from scrap -- much of it through the recycling of old batteries. It imports about one-quarter of a million tons. Lead is classified as a strategic mineral. Demand is projected to increase somewhat in the next couple of decades, but environmental concerns will limit the increase. The United States has large ore reserves that are expected to last well beyond the end of this century at current production rates even without major new discoveries. At the end of 1982 the price was about 22 cents per pound.

The major uses of zinc are in galvanizing, brass and bronze products, castings, rolled zinc and in pigments or other chemicals. About six million metric tons are produced annually, with the United States producing somewhat less than a quarter of a million tons. Domestic production has decreased dramatically over the past five years, largely as a result of the closing down of most zinc smelters because of environmental problems. Imports into the United States are about one million tons per year. Zinc is listed as a strategic and critical metal. Both world-wide and domestic consumption are expected to increase at a moderate rate over the next twenty years. At the end of 1982 the price of zinc was about 38 cents per pound.

B. NONMETALLIC MINERAL RESOURCES

1. Known Mineral Deposits

There are no known nonmetallic mineral deposits located within the Clan Alpine GRA which have shown any past production.

2. Known Prospects, Occurrences and Mineralized Areas

Several fluorite prospects located within the GRA boundary have been identified by Papke (1979). The Purple Star prospect in Sec. 19, T 19 N, R 35 E has explored a nearly vertical vein about two and one half feet wide that cuts a Miocene age latite flow. The Little Jim prospect, is located in Sec. 31 of T 19 N, R 35 E on a ridge several hundred feet west of the road. A N 40° W vein contains light-gray fluorite and some altered dacite. The property has been trenched and an old vertical shallow shaft presumably was sunk in search of precious metals (Papke, 1979).

The Nevada Wonder vein, the main producer of precious metals in the Wonder district contains minor fluorite as gangue material in the quartz adularia veins.

A Miocene sedimentary unit outcrops in two areas of the WSA; along the southeastern border and on the east flank of the range north of the Clan Alpine Ranch. To the south of the GRA near Eastgate this unit contains zeolitized tuffs and elsewhere diatomite beds have been reported. It is unknown whether this unit in the WSA contains zeolites or diatomite.

3. Mining Claims, Leases and Material Sites

It is unknown whether claims or leases have been located in the Clan Alpine Mountains GRA for nonmetallic minerals.

On the east flank of the Clan Alpine Mountains, several gravel pits have produced an unknown quantity of aggregate. It is not known if they are currently active.

4. Mineral Deposit Types

The three fluorite prospects and occurrences located within the GRA occur in epithermal veins that cut volcanics ranging in composition from rhyolite to dacite.

At the Purple Star prospect fluorite occurs in a two-foot wide vein in small irregularly distributed masses, and makes up about a third of the vein material. Quartz and unreplaced country rock form the remainder of the vein material. The fluorite mineralization at the Little Jim prospect is similar, but the vein is only about one foot wide.

Fluorite in the Nevada Wonder mine occurs as gangue material in the precious metal bearing quartz-adularia vein.

5. Mineral Economics

Fluorite is the only nonmetallic mineral known to occur within the Clan Alpine Mountains GRA. These prospects and the occurrence at the Nevada Wonder mine lie outside the boundary of WSA NV 030-102. Due to the narrowness of the veins and the apparent lack of tonnage potential at the Purple Spar and Little Jim prospects, it is doubtful that these properties could be economically developed. Fluorite in the Nevada Wonder mine occurs only as gangue material and not in sufficient quantities to be of any consequence.

By far the greatest use of fluorite (or fluorspar) is in the production of hydrofluoric acid, which has many industrial applications. Other uses are in steelmaking, welding rods, refining of a number of metals, and in the production of certain glasses. World production fluorine, the principal component of fluorite, is about 2.5 million tons annually, of which the United States produces less than 100 thousand tons, nearly half of this being in the form of fluorsilicic acid that is a byproduct of phosphate production. United States consumption is about 700 thousand tons annually, with more than half of the shortfall imported from Mexico, and the remainder mostly from South Africa, Spain and Italy. Fluorite is a strategic and critical mineral. United States demand for fluorite is expected to increase by about 50% by the year 2000, and probably all of the increase will be imported. In 1980 the price of fluorite was about $65 to $85 per ton, depending upon the quality.

C. ENERGY RESOURCES

Uranium and Thorium Resources

1. Known Mineral Deposits

There are no known uranium or thorium deposits in the WSA or GRA.

2. Known Prospects, Mineral Occurrences and Mineralized Areas

Uranium occurrences are shown on the uranium Land Classification - Occurrence Map at the back of the report. There are known radioactive occurrences southwest of the WSA in the GRA and south of the southwestern corner of the GRA. The occurrence within the GRA is at the Martin claims (Sec. 12(?), T 18 N, R 34 E) where torbernite is present along fractures in Tertiary rhyolite, and the other occurrence is at the Chalk Mountain mine (Sec. 23, T 17 N, R 34 E) where anomalous radioactivity is associated with a silver-lead vein in Triassic carbonates (Garside,

1973).

In addition to the above mentioned radioactive occurrences, a stream sediment sample was obtained from the Horse Canyon area anomalous in uranium. A single stream sediment sample anomalous in uranium was also taken from the Cherry Creek area located in the southwestern part of the WSA. It is recommended that these uranium anomalies be validated by additional sampling and the areas investigated for their economic potential.

In the Cow Canyon area, located in the southeastern quarter of T 21 N, R 36 E, Houston International has explored the uranium potential and subsequently dropped the claims.

3. Mining Claims

Known uranium claims in the GRA, include the Martin claims (Garside, 1973) which are described above, and the Cow claims. The Cow claims originally located by Houston International Mining Company were staked in the southeastern quarter of T 21 N, R 36 E. Subsequent to Houston International's evaluation of the uranium potential in this area, the claims were dropped in 1982. (Personal communication, Houston International.) There are no known thorium claims in the GRA.

4. Mineral Deposit Types

Deposit types cannot be discussed because there are no uranium or thorium deposits in the WSA or GRA.

5. Mineral Economics

Uranium and thorium appear to be of little economic value in the GRA due to the lack of known deposits of these elements.

Uranium in its enriched form is used primarily as fuel for nuclear reactors, with lesser amounts being used in the manufacture of atomic weapons and materials which are used for medical radiation treatments. Annual western world production of uranium concentrates totaled approximately 57,000 tons in 1981, and the United States was responsible for about 30 percent of this total, making the United States the largest single producer of uranium (American Bureau of Metal Statistics, 1982). The United States ranks second behind Australia in uranium resources based on a production cost of $25/pound or less. United States uranium demand is growing at a much slower rate than was forecast in the late 1970s, because the number of new

reactors scheduled for construction has declined sharply since the accident at the Three Mile Island Nuclear Plant in March, 1979. Current and future supplies were seen to exceed future demand by a significant margin and spot prices of uranium fell from $40/pound to $25/pound from January, 1980 to January, 1981 (Mining Journal, July 24, 1981). At present the outlook for the United States uranium industry is bleak. Low prices and overproduction in the industry have resulted in the closures of numerous uranium mines and mills and reduced production at properties which have remained in operation. The price of uranium at the end of 1982 was $19.75/pound of concentrate.

Oil and Gas Resources

1. Known Oil and Gas Deposits

There are no known oil and gas deposits in the GRA.

2. Known Prospects, Oil and Gas Occurrences and Petroliferous Areas

No oil seeps or shows in wells are known in the GRA or in the bordering areas. This GRA is not within the petroliferous miogeosyncline of eastern Nevada and Utah.

3. Oil and Gas Leases

There are Federal oil and gas leases covering over 120 sections in the WSA and an equal amount in the rest of the GRA. The leases blanket both the Dixie and Edwards Creek Valleys and the high areas of the Clan Alpine Mountains.

4. Oil and Gas Deposit Types

Oil deposits that have been found and developed, and those that are being explored for in the Basin and Range to date, have been limited to the Upper Paleozoic section of the miogeosyncline and the Tertiary section of the intermontane basins. The source rocks are assumed to be in Paleozoic horizons, such as the Mississippian Chainman Shale, and perhaps also Tertiary section.

The reservoirs at the Trap Spring and Eagle Springs oil fields in Railroad Valley are the Oligocene Garrett Ranch volcanics or equivalent, which produce from fracture porosity; or the Eocene Sheep Pass Formation, a freshwater limestone. Minor production has been recorded from the Ely(?) Formation of Pennsylvanian age at Eagle Springs. It may be that production also comes from other units in

the Tertiary or Paleozoic sections in the Blackburn oil field in Pine Valley or the Currant and Bacon Flat oil fields in Railroad Valley.

5. Oil and Gas Economics

The low level of production from Nevada Basin and Range oil fields, which are remote from existing pipelines, existing refineries and consuming areas, necessitates the trucking of the crude oil to existing refineries in Utah, California and Nevada. Since the discovery of oil in Nevada in 1953, the level of production has fluctuated. Factors which have affected the production from individual wells are: reservoir and oil characteristics; Federal regulations; productivity; environmental constraints; willingness or ability of a refiner to take certain types of oil; and of course, the price of the producer, which is tied to regional, national and international prices.

Geothermal Resources

1. Known Geothermal Deposits

The Tom Ormechea well (Locality #1 on the Geothermal Occurrence and Land Classification Map) in Edwards Creek Valley is the only known thermal deposit in the GRA. This 100-foot deep well flows 76°F water. In Dixie Valley there are several shallow wells (#2) with temperatures of 70-75°F (Garside and Schilling, 1979).

On the opposite side of Dixie Valley, the Dixie Comstock Mine (#3) has "hot" water in the workings at less than 75 feet, and 162°F water at Dixie Hot Springs (#4).

2. Known Prospects, Geothermal Occurrences, and Geothermal Areas

All along the Dixie Valley side of the GRA, numerous energy companies have drilled shallow temperature gradient holes as part of a major exploratory effort.

3. Geothermal Leases

There are at least 75 sections under lease in the valley and lower mountain slopes of the GRA, including some in the WSA.

4. Geothermal Deposit Types

Geothermal resources are hot water and/or steam which occur in subsurface reservoirs or at the surface as springs. The temperature of a resource may be about 70°F (or just above average ambient air temperature) to well above 400°F in the Basin and Range Province.

The reservoirs may be individual faults, intricate fault-fracture systems, or rock units having intergranular permeability -- or a combination of these. Deep-seated normal faults are believed to be the main conduits for the thermal waters rising from thousands of feet below in the earth's crust.

The higher temperature and larger capacity resources in the Basin and Range are generally hydrothermal convective systems. The lower temperature reservoirs may be individual faults bearing thermal water or lower pressured, permeable rock units fed by faults or fault systems. Reservoirs are present from the surface to over 10,000 feet in depth.

5. Geothermal Economics

Geothermal resources are utilized in the form of hot water or steam normally captured by means of drilling wells to a depth of a few feet to over 10,000 feet in depth. The fluid temperature, sustained flow rate and water chemistry characteristics of a geothermal reservoir, as well as the end use, determine the depth to which it will be economically feasible to drill and develop each site.

Higher temperature resources (above 350°F) are currently being used to generate electrical power in Utah and California, and in a number of foreign countries. As fuel costs rise and technology improves, the lower temperature limit for power will decrease appreciably -- especially for remote sites.

All thermal waters can be beneficially used in some way, including fish farming (68°F), warm water for year-round mining in cold climates (86°F), residential space heating (122°F), greenhouses by space heating (176°F), drying of vegetables (212°F), extraction of salts by evaporation and crystalization (266°F), and drying of diatomaceous earth (338°F). These are only a few examples.

Unlike most mineral commodities remoteness of resource location is not a drawback. Domestic and commercial use of natural thermal springs and shallow wells in the Basin and Range province is a historical fact for over 100 years.

Development and maintenance of a resource for beneficial

use may mean no dollars or hundreds of millions of dollars, depending on the resource characteristics, the end use and the intensity or level of use.

D. OTHER GEOLOGICAL RESOURCES

There are no other unusual or unique geological resources known to exist in the WSA. Coal is not known in the GRA, and there is no known potential for coal.

E. STRATEGIC AND CRITICAL MINERALS AND METALS

A list of strategic and critical minerals and metals provided by the BLM was used as a guideline for the discussion of strategic and critical materials in this report.

The Stockpile Report to the Congress, October 1981 - March 1982, states that the term "strategic and critical materials" refers to materials that would be needed to supply the industrial, military and essential civilian needs of the United States during a national emergency and are not found or produced in the United States in sufficient quantitiesto meet such need. The report does not define a distinction between strategic and critical minerals.

Antimony, tungsten, and fluorspar, currently listed as strategic and critical minerals, occur within the GRA. Approximately 300 tons of antimony metal has been produced from the Bernice district on the east side of the range (Wilden and Speed, 1974). Principal production has come from the Antimony King mine with lesser amounts produced from the Drum, I.H.X., Lofthouse and Hoyt mines. But due to the narrowness of the veins, costly underground development of these properties would be required. This would preclude the interest of major mining companies.

Tungsten has been produced from extensive underground workings of the Tungsten Mountain mine located at the northern end of the Alpine district. The mine produced tungsten from scheelite in tactite between 1954 and 1961 (Wilden and Speed, 1974). Total past production figures for this property are unknown, as are the amounts of tungsten remaining in the mine.

Lead, mercury, copper and silver, listed on the current stockpile list, have also been produced from the Alpine, Bernice and Wonder district.

Only minor amounts of lead, silver and mercury have been produced from the Alpine and Bernice districts from underground mines that would not be profitable under current economic conditions.

Significant past production of silver and lead and minor copper has come from the Nevada Wonder mine in the Wonder district. The Nevada Wonder vein was the only deposit in the district that produced sufficient ore to be profitably mined. The Nevada Wonder mine was worked to the depth of more than 2,000 feet indicating that additional ore reserves would be at depth and extremely costly to extract. It is not known if there is potential for disseminated precious metals in this area.

IV. LAND CLASSIFICATION FOR G-E-M RESOURCES POTENTIAL

Willden and Speed's (1974) Churchill County map at a scale of 1:250,000 is the only geologic map available which covers the WSA. The scale of this map is not adequate to show a great deal of detail which would be of importance in evaluating mineral potential. Only grass lithologies and the most major of structures are presented. Volcanic rocks which make up the majority of the WSA are only marginally subdivided and no veining or alteration is outlined. Even though the map detail is not satisfactory for adequately evaluating mineral resources, the quality and level of confidence in the map, per se, is good. The majority of the data on mineral resources comes from the publication which includes the above map. This data is not of a comprehensive detailed nature for the majority of the deposits and occurrences but it is a good summary of what is present. Overall, however, the quantity of data concerning mineral resources is low but the quality and level of confidence in that data is high.

Land classification areas are numbered starting with the number 1 in each category of resources. Metallic mineral land classification areas have the prefix M, e.g., M1-4D. Uranium and thorium areas have the prefix U. Nonmetallic mineral areas have the prefix N. Oil and gas areas have the prefix OG. Geothermal areas have the prefix G. Sodium and potassium areas have the prefix S. The saleable resources are classified under the nonmetallic mineral resource section. Both the Classification Scheme, numbers 1 through 4, and the Level of Confidence Scheme, letters A, B, C, and D, as supplied by the BLM are included as attachments to this report. These schemes were used as strict guidelines in developing the mineral classification areas used in this report.

Land classifications have been made here only for the areas that encompass segments of the WSA. Where data outside a WSA has been used in establishing a classification area within a WSA, then at least a part of the surrounding area may also be included for clarification. The classified areas are shown on the 1:250,000 mylars or the prints of those that accompany each copy of this report.

In connection with nonmetallic mineral classification, it should be noted that in all instances areas mapped as alluvium are classified as having moderate favorability for sand and gravel, with moderate confidence, since alluvium is by definition sand and gravel. All areas mapped as principally limestone or dolomite have a similar classification since these rocks are usable for cement or lime production. All areas mapped as other rock, if they do not have specific reason for a different classification, are classified as having low favorability, with low confidence, for nonmetallic mineral potential, since any mineral material can at least be used in construction applications.

1. LOCATABLE RESOURCES

a. Metallic Minerals

WSA NV 030-102

M1-4D. This classification area of high favorability with a high confidence level includes the areas of past production in the Bernice district including the Bernice mine (#4), the Antimony King mine (#6) and the Hoyt mine (#5). The Lofthouse mine, another antimony producer, is also included in this classification even though it is separated a distance of several miles south of the main district. Production has included silver and antimony. All production came from vein deposits containing abundant quartz in Mesozoic sediments.

M2-4D. This classification area of high favorability with a high confidence level covers the Nevada Gold group and the Tungsten Mountain mine on the east side of the range and is considered a part of the Alpine district. Gold-silver production was reported from the Gold group, while tungsten was produced from Tungsten Mountain. Both mines are similar though in that they are adjacent to the nearby grandiorite which is intrusive into Mesozoic sediments. Mineralization at the tungsten mine is the result of that intrusive. A vein at the gold group parallels a granodiorite dike in close proximity to the intrusive.

M3-4D. This classification area of high favorability with a high confidence level in the Florence Canyon area has been a past gold and silver producer from quartz veins and silicified zones in the volcanic rocks.

M4-4D. This classification area of high favorability with a high confidence level covers the Wonder mining district south of the WSA. It was a major producer of silver and gold from veins in volcanic rocks.

M5-4D. This is the Red Bird mine north of the WSA which produced mercury from cinnabar-bearing veins in Mesozoic sediments.

M6-3C. This classification area of moderate favorability with a moderate confidence level includes all the area of exposed Mesozoic sediments in the WSA. This is the horst feature in the central portion of the range. This includes the areas surrounding the Bernice and Alpine mining districts. It also includes the Cretaceous(?) intrusives, one of which is closely associated with mineralization in the Tungsten Mountain area. Reasons for the 3C classification include:

1. Proximity to known mineral deposits (areas classified 4D).

2. Similar geologic environment as the known mineral deposits.

3. Intrusive activity.

4. Abundant mining claims.

5. Structurally complex.

M7-3B. This area of moderate favorability with a low confidence level is similar to M6-3C but includes the area of older volcanics which overlie the Mesozoic rocks in the central horst. These volcanics are probably relatively thin. This area also has numerous claims, especially that area of older volcanics cropping out northwest of Tungsten Mountain. The low confidence level (B) is because the available evidence is considered to be indirect as the nature of the underlying Mesozoic rocks is uncertain.

M8-2B. This area of low favorability with a low confidence level includes the large gabbroic intrusive which extends into the northern portion of the WSA on the northwest flank of the range. The gabbroic complex is described as having highly differentiated facies, but no known metallic mineral occurrences have been described here. The entire area has been staked by Southland Royalty, reportedly for rare earths, but nothing else is known about this claim at this time.

M9-3B. This classification area of moderate favorability with a low confidence level includes all the remaining rhyolitic to rhyodacitic volcanic rocks in the WSA. Reasons for the 3 (moderate favorability classification) include:

1. There is precious mineral mineralization in these rocks south at Wonder and in the Alpine district at Florence Canyon (M4-4D and M3-4D).

2. The graben portion of the structurally complex underlies this part of the range. The horst is the middle portion of the study area which has been uplifted and now exposes the Mesozoic sediments which contain known mineral deposits. Here, tungsten, gold, silver and antimony have been mined. Beneath all these younger volcanics, the Mesozoics may show similar mineralization along veins and in association with buried intrusives. The youngest volcanic unit,

the basalts, are also included here as they are relatively thin and mainly occupy only small outcrop areas or are found along the crest of the range where access beneath them would be feasible.

3. There are scattered claims in the volcanics which indicate potential interest. Claims include those surrounding Florence Canyon, east of the Bernice district, and Houston International's large claim group several miles southwest of Bernice.

This classification area lacks available detail and may be subject to modification with the acquisition of additional information.

M10-3A. This area of moderate favorability with a very low confidence level includes all the alluvium in the WSA where there is no indication of mineralization and the nature of the underlying bedrock is unknown. The area has been given a moderate favorability because the entire outcrop area of the Clan Alpine range is considered high to moderate favorability, therefore, it is logical to assume that the bedrock beneath the alluvium would be similar, and hence the 3 classification. The confidence level of A is due to the lack of direct evidence to arrive at this conclusion.

b. Uranium and Thorium

WSA NV 030-102

U1-2B. This land classification covers the majority of the WSA and the northeast and southwest corners of the GRA. Most of the area is covered by Tertiary rhyolites and rhyodacites except for the northern part of the WSA which is covered by Triassic sediments which have been intruded by Cretaceous grandiorite. Minor amounts of Jurassic Gabbro are exposed north of the WSA in the GRA. The area has low favorability with a low confidence level for fracture-filled, vein and caldera-related uranium deposits. Stewart and Carlson (1976) suggest the presence of a major volcanic center in the southwestern part of the WSA, and also a caldera which may intersect the southeastern corner of the GRA. These features, the uranium occurrence at the Martin and Cow claims, and the presence of anomalous uranium in stream sediment samples, mentioned above, indicate that there is some potential for fracture filled, possibly caldera-related uranium deposits in the rhyolites in the WSA. In addition anomalous uranium concentrations (10-20 ppm) were detected in stream sediments associated with contacts between rhyolite and basalt flows in the southwestern portion of the WSA (Wagoner, 1978), indicating that these rocks are possible

uranium sources.

Another possible location for contact-related or fracture-filled deposits is in the Triassic sediments which were intruded by granodiorite in the northern part of the WSA.

The area has very low favorability, with a very low confidence level, for thorium due to the lack of granitic or pegmatitic source rocks.

U2-2B. This land classification covers areas marginal to the WSA and small areas in the northern and southern parts of the GRA. These areas are covered by Tertiary-Quaternary alluvial deposits which have low favorability with a low confidence level for epigenetic sandstone-type uranium deposits. The silicic tuffs and rhyolites exposed in the WSA and GRA are a possible source for uranium which could be leached by ground water and reprecipitated in reduced zones in the alluvium in basins adjacent to the volcanics. Anomalous uranium values have been noted in sediments derived from rhyolitic volcanics in the WSA, indicating that these rocks may be sources for uranium to this type of deposit.

The area has very low favorability with a very low confidence level for thorium deposits in monazite sands due to the apparent lack of granite or pegmatite source rocks.

c. Nonmetallic Minerals

WSA NV 030-102

N1-2B. This low favorability classification area with a low confidence level includes all the Mesozoic sediments in the WSA. These units consist predominantly of shales and siltstone with smaller amounts of limestone and sandstone, and could possibly be utilized in certain industrial applications such as cement manufacture or as construction materials, depending on local market needs.

M2-2B. This low favorability area with a low confidence level includes the granitic intrusive rocks in the WSA which are on either side of the range in the Mesozoic sediment exposures in the horst. These could possibly be used for construction materials.

N3-2B. This low favorability area with a low confidence level is the gabbroic intrusive complex in the northern portion of the WSA. The literature (Willden and Speed, 1974) indicates that this complex is highly differentiated near the periphery of the body and contains such nonmetallic commodities such as olivine and feldspar. It is unknown whether concentrations of these minerals are

sufficient for any economic exploration. Claims have been staked on this gabbroic complex, reportedly for rare earths.

N4-2B. This low favorability area with a low confidence level includes all the volcanic rocks in the WSA. They could possibly be utilized in local construction material applications. Some fluorite occurrences are known in these volcanics further south, but none have been reported within the WSA. The fluorite is only present in minor amounts.

N5-3C. This area of moderate favorability with a moderate confidence level includes all the alluvium in the WSA and probably could be utilized as sand and gravel in local construction applications.

2. LEASABLE RESOURCES

a. Oil and Gas

WSA NV 030-102

OG1-2A. The WSA is outside of the main miogeosyncline province of the Nevada Basin and Range which is known to be favorably petroliferous. Even so major energy companies are leasing, and have been exploring for petroleum in this immediate region for some years. Approximately 120 sections of the WSA have been leased.

This classification covers valley and lower slope mountain areas underlain by Quaternary valley fill and Tertiary volcanics which are presumed to be on the Tertiary age intermontane basin side of the major faults that separate them from the Clan Alpine Mountains horst block. There may be a reasonably thick section of prospective rocks at depth, though there has been no drilling to prove or disprove this.

OG2-1D. This classification covers the main mountain horst which is mapped as Triassic shale and siltstone, Jurassic gabbroic rocks, Cretaceous granitic intrusives, and is overlain by Tertiary volcanics. This section is not thought to be prospective for oil and gas, based on known petroleum occurrences in Nevada.

The reason for leasing over this section is an unanswered question.

b. Geothermal

WSA NV 030-102

G1-4D. This classification is on structural trend with and immediately contiguous to the 76°F Tom Ormechea well, which would be amenable to low-temperature direct use of the geothermal resource.

G2-3B. The range front structural environment is similar to classification G1 and most of the known geothermal deposits in this region. The normal faults which are mapped or hidden by valley alluvium, frequently act as conduits for thermal waters. This region, Dixie Valley, is particularly prospective. There are a number of leases in this area at the north end of the WSA.

G3-3A. This classification includes the main part of the Clan Alpine Mountains. The faulting, which is so important in geothermal deposits, passes from the valleys into the mountains in many areas. Just six miles to the northeast (off map), the AMAX McCoy geothermal prospect is known to be very prospective (Olson and others, 1979). This large prospect is in the mountains rather than in the valley. Due to the highly prospective nature of this immediate region, this portion of the WSA has been given a relatively high favorability rating.

c. Sodium and Potassium

WSA NV 030-102

S1-1D. This classification applies to the entire WSA. There is no indication of favorability for the accumulation of resources of sodium and potassium in the WSA. There is no classification map for this commodity.

3. SALEABLE RESOURCES

Saleable resources, sand and gravel, have been discussed above under nonmetallics and include area N5-3C.

V. RECOMMENDATIONS FOR ADDITIONAL WORK

The Clan Alpine Range is a geologically and structurally complex area that has abundant mineralization. The entire area is believed to have moderate to high potential for metallic mineral resources. This study is not an in-depth evaluation of this area, but an in-depth evaluation is necessary. Further recommendations to help in the evaluation of the mineral potential of this area include:

1. Further discussion with all mining claimants in the area (Our initial inquiries have produced only sketchy and limited information to date).

2. Detailed geological mapping of the entire area with emphasis on the mining districts to determine potential pathfinders to mineralization, including alteration, structure, vein extensions, etc.

3. All mining claims in the WSA should be looked at in detail to determine their mineral character or potential.

4. It should be emphasized that the Mesozoic rocks underlying the volcanics have a definite mineral potential based on their available exposures elsewhere.

VI. REFERENCES AND SELECTED BIBLIOGRAPHY

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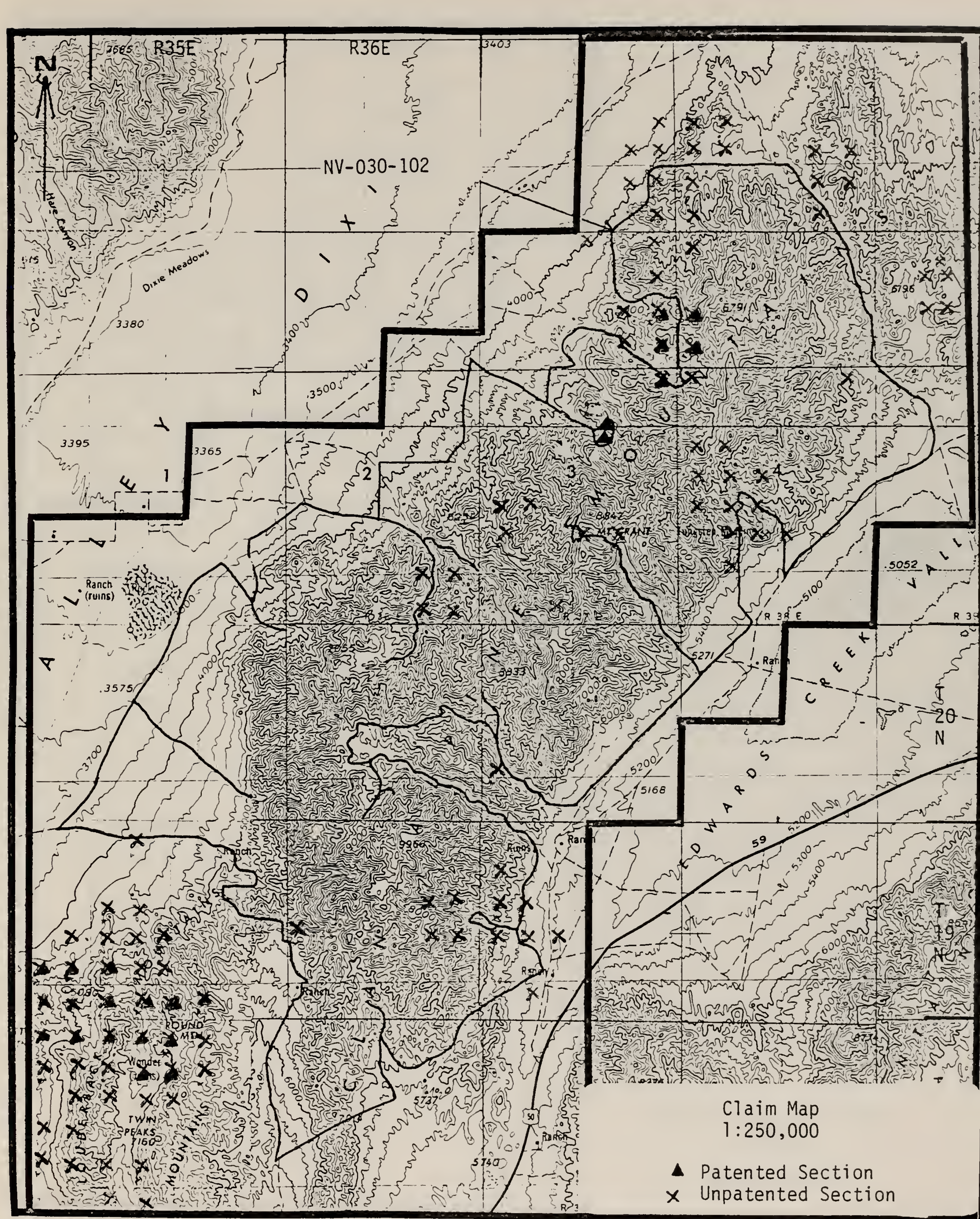
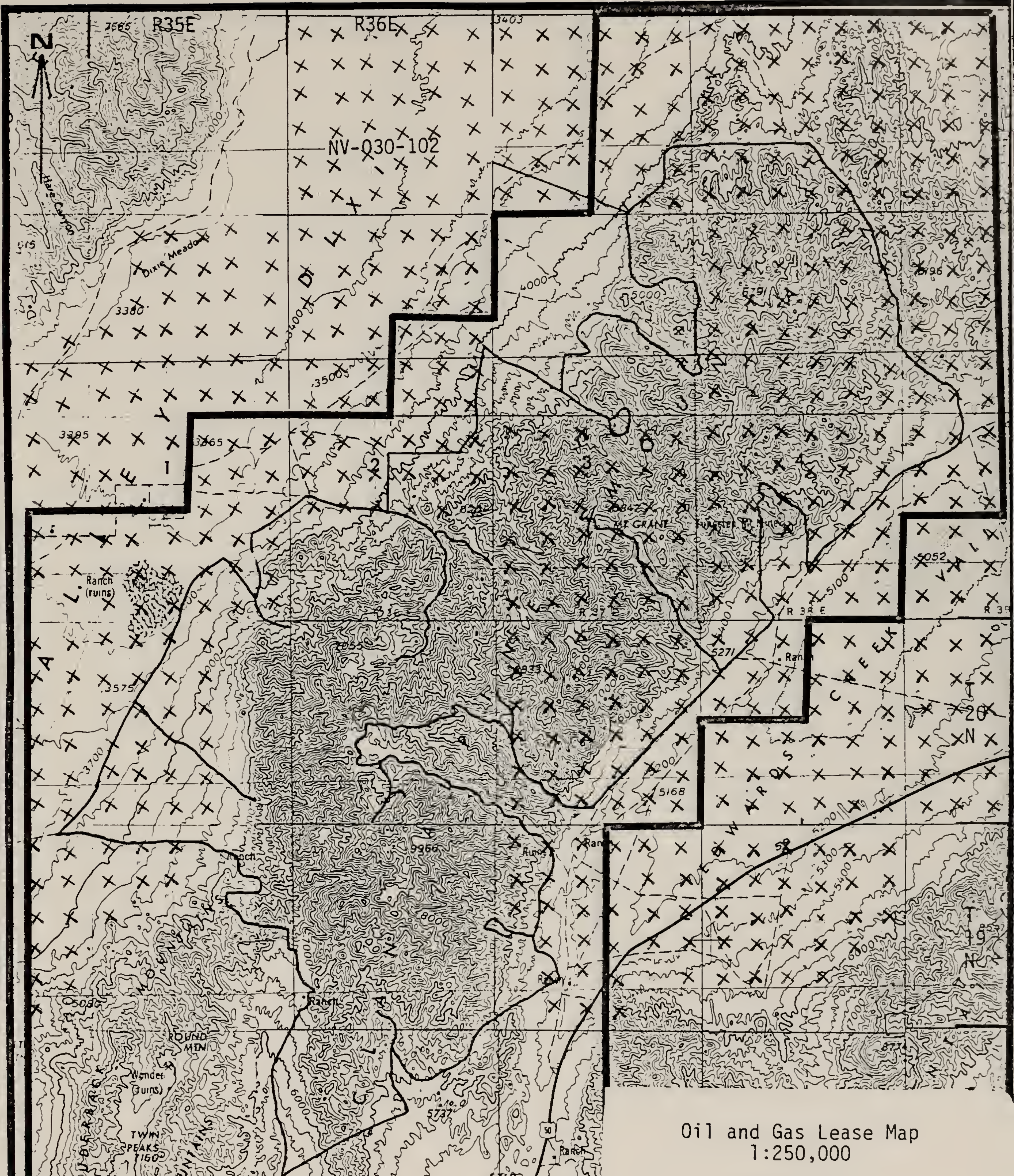


Claim Map
1:250,000

▲ Patented Section
× Unpatented Section

Clan Alpine Mountains GRA NV-05



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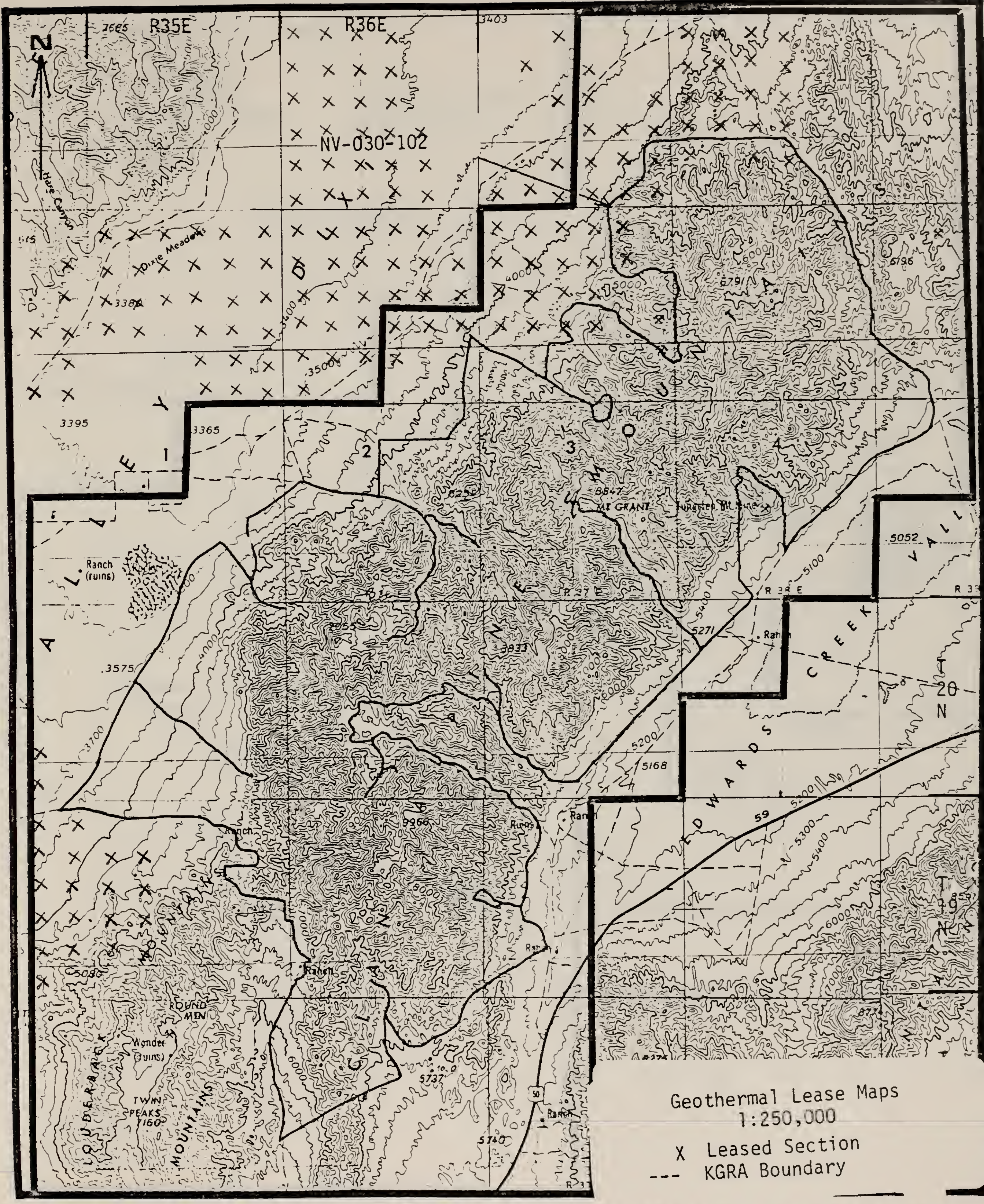
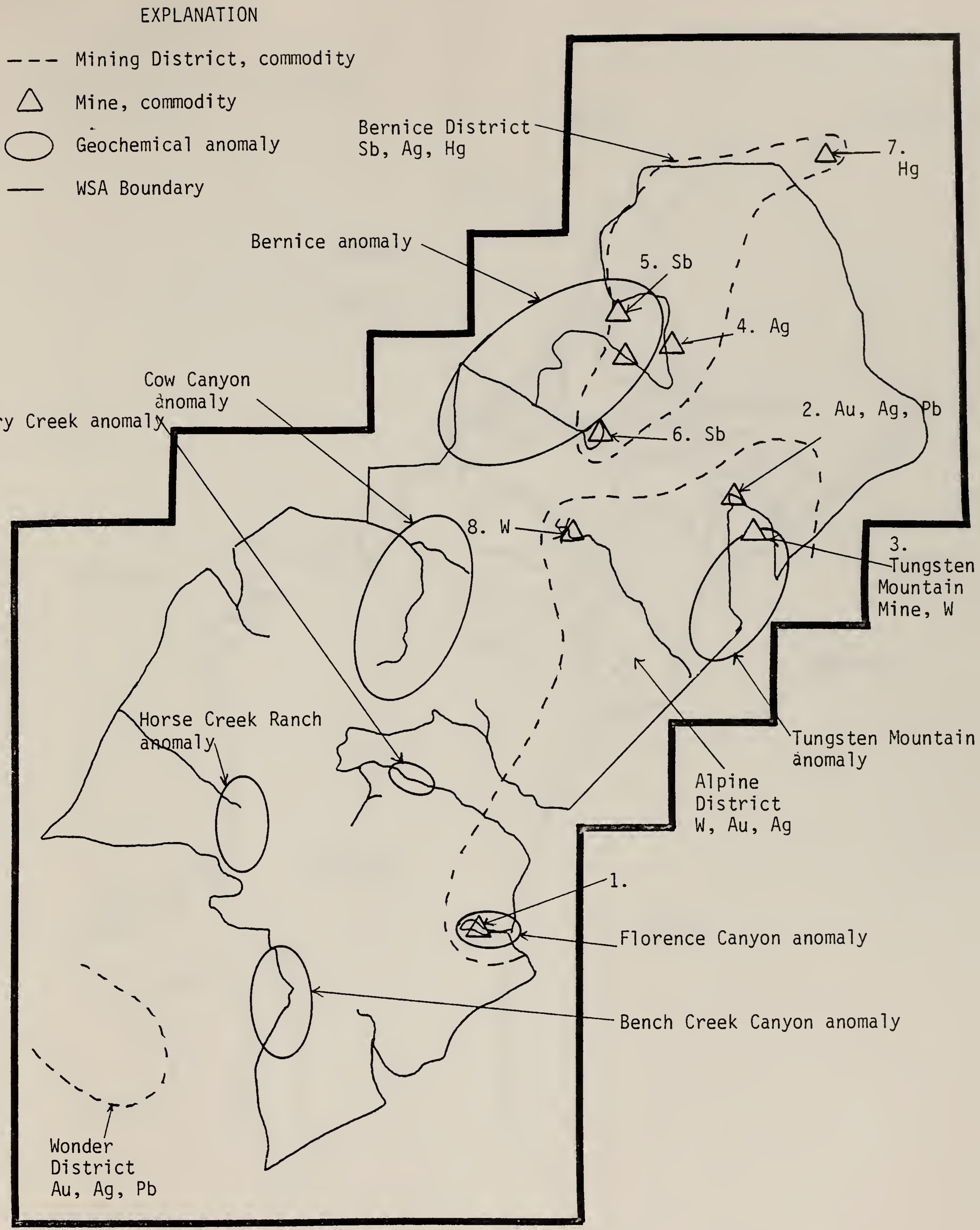


Geothermal Lease Maps
1:250,000

X Leased Section
--- KGRA Boundary

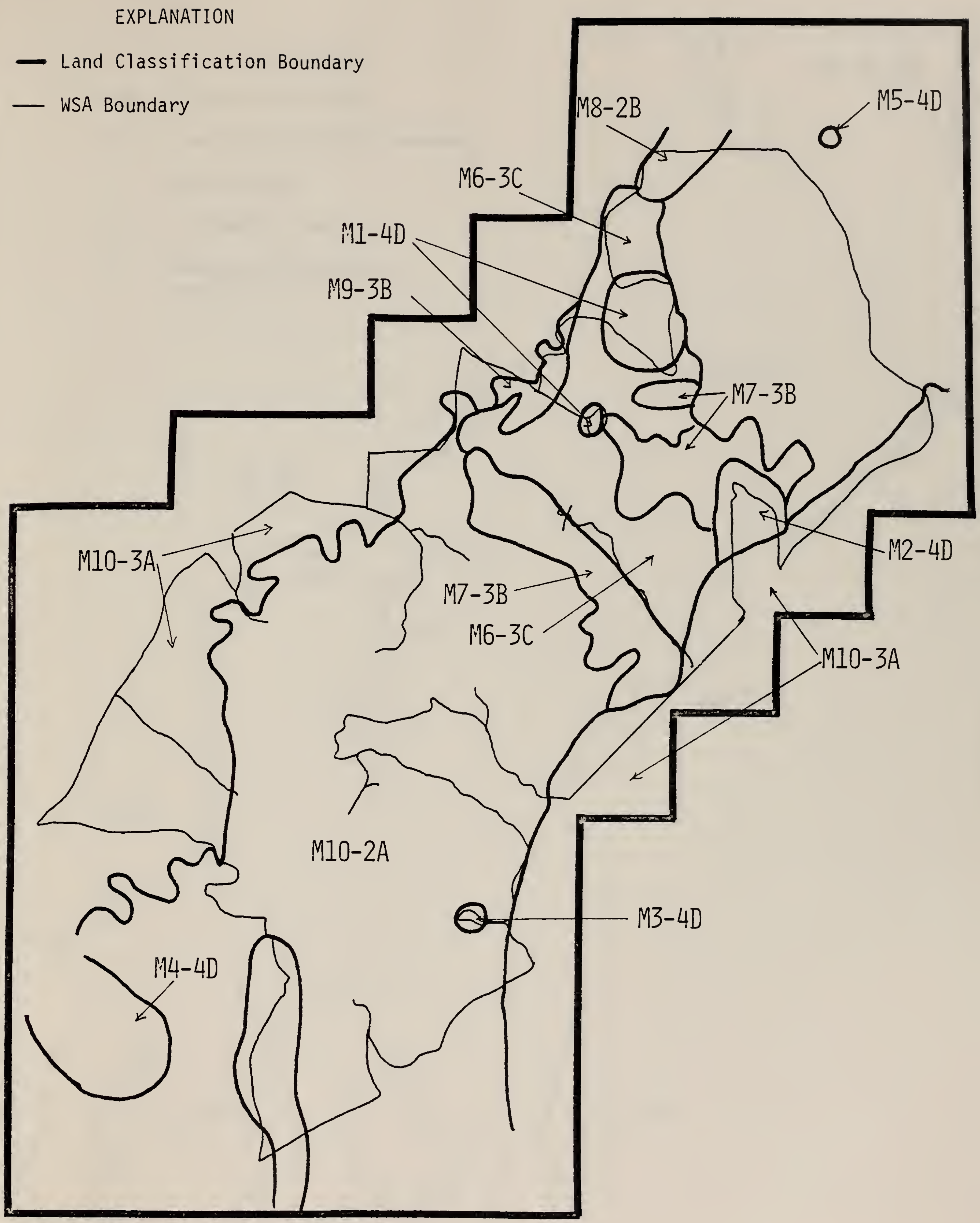
Clan Alpine Mountains GRA NV-05



Mineral Occurrence Map
Metallics

Clan Alpine Mountains GRA NV-05

Scale 1:250,000



Land Classification - Metallics

Clan Alpine Mountains GRA NV-05
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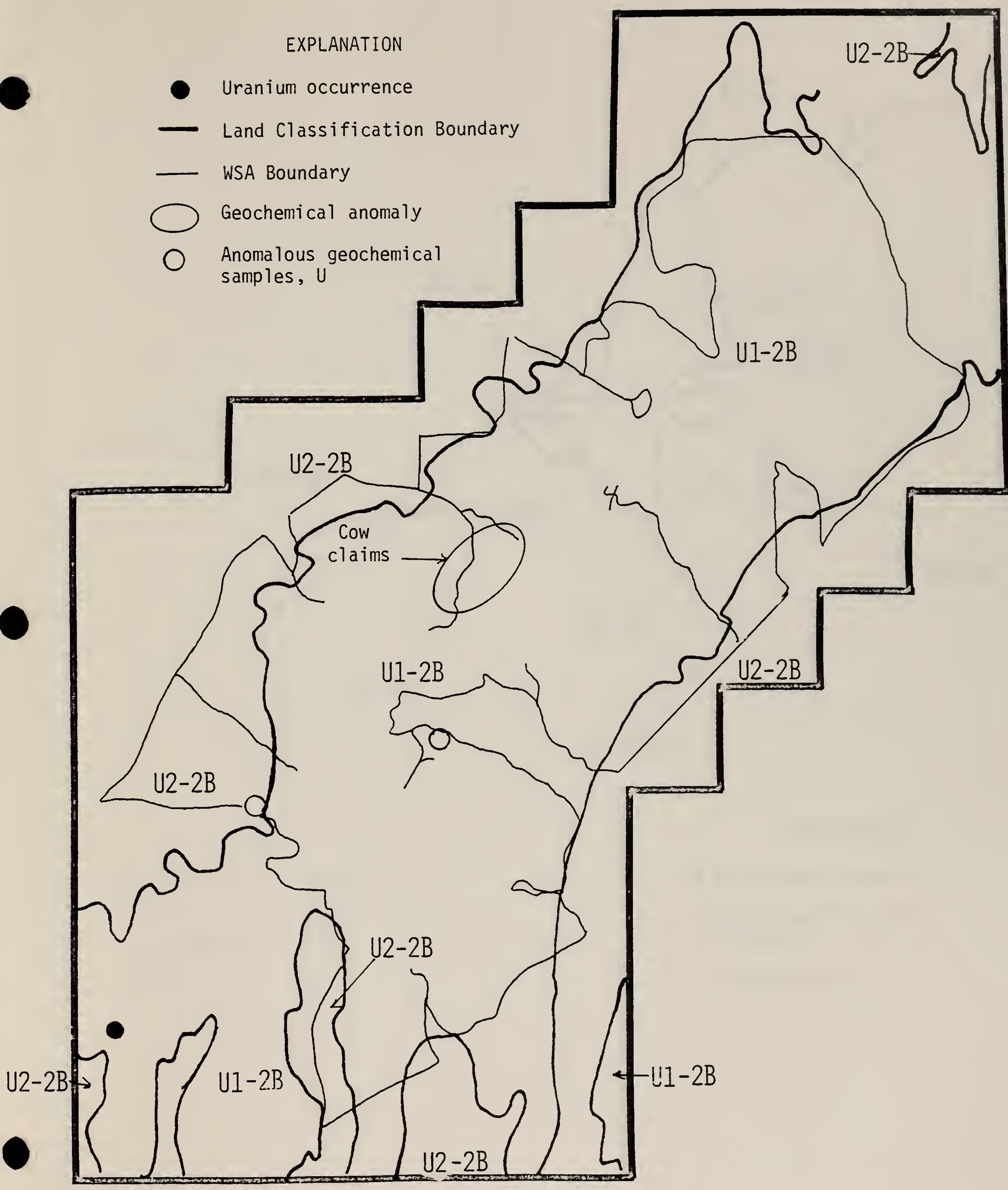

Land Classification and Mineral Occurrence Map/Uranium   Clan Alpine Mountains GRA NV-05
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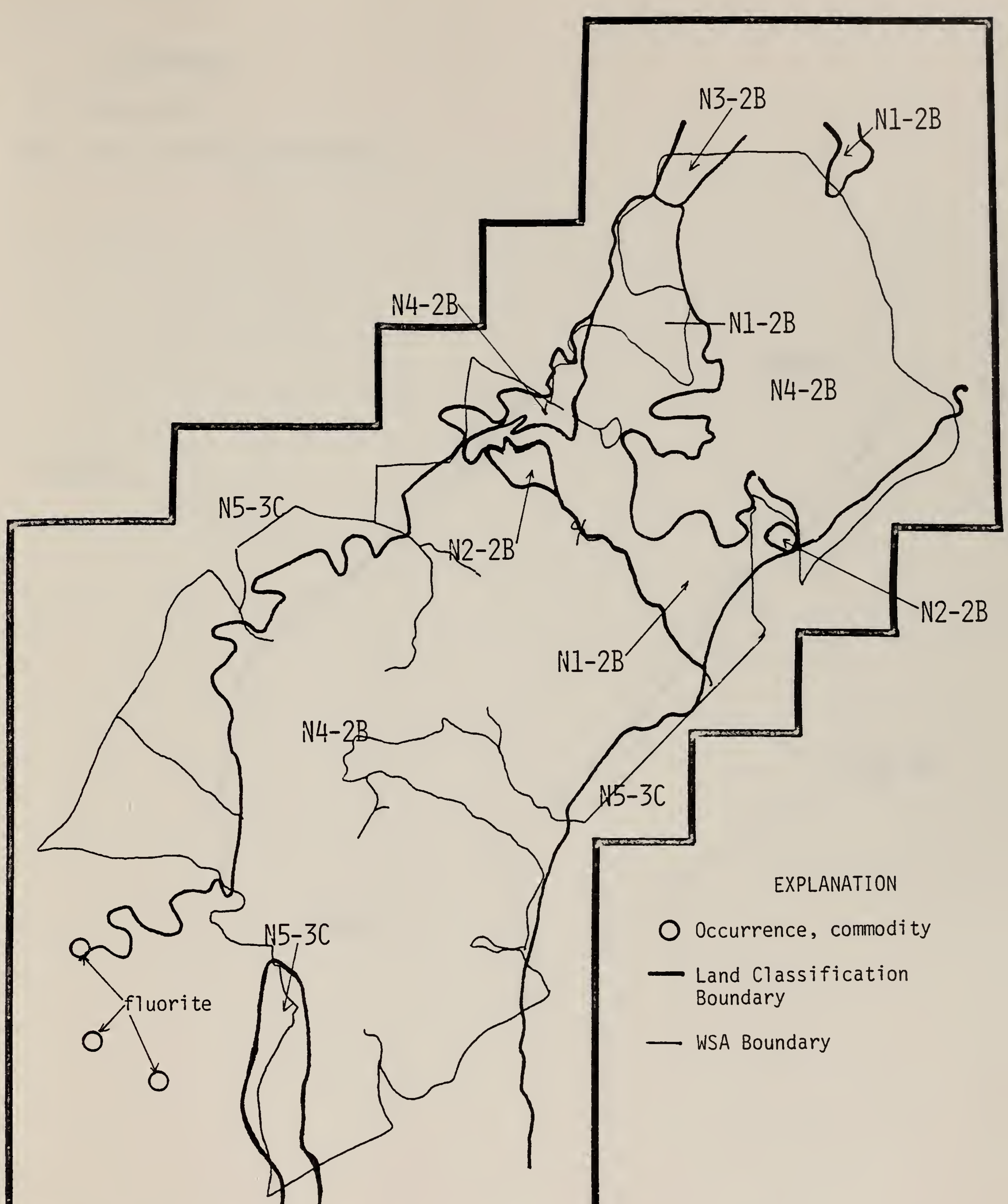

Land Classification and Mineral Occurrence Map/Nonmetallics

Clan Alpine Mountains GRA NV-05
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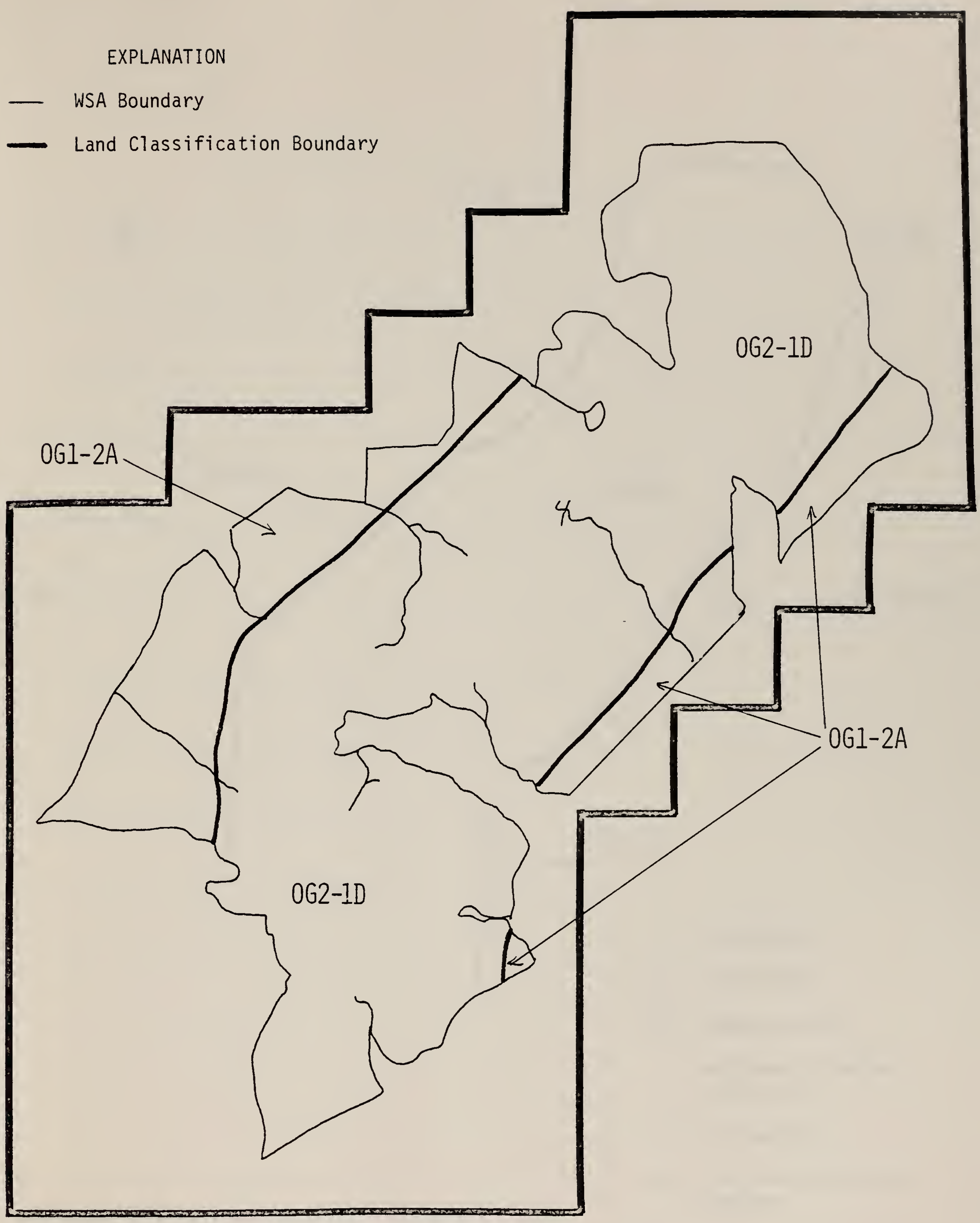

Land Classification - Mineral Occurrence Map/
Oil and Gas

Clan Alpine Mountains GRA NV-05
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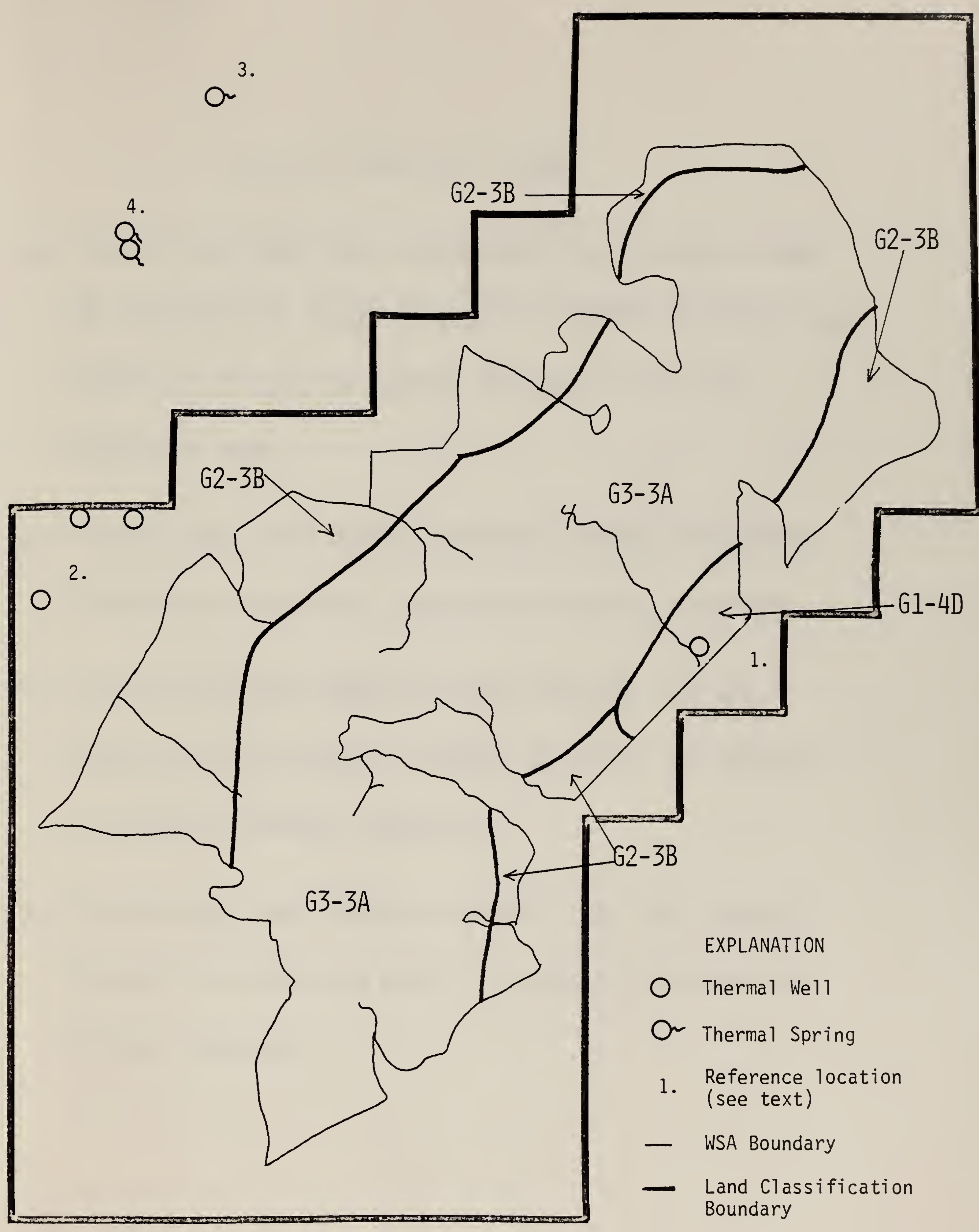

Land Classification - Mineral Occurrence Map/Geothermal

Clan Alpine Mountains GRA NV-05

Scale 1:250,000

LEVEL OF CONFIDENCE SCHEME

A. THE AVAILABLE DATA ARE EITHER INSUFFICIENT AND/OR CANNOT BE CONSIDERED AS DIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES WITHIN THE RESPECTIVE AREA.

B. THE AVAILABLE DATA PROVIDE INDIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

C. THE AVAILABLE DATA PROVIDE DIRECT EVIDENCE, BUT ARE QUANTITATIVELY MINIMAL TO SUPPORT TO REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

D. THE AVAILABLE DATA PROVIDE ABUNDANT DIRECT AND INDIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

CLASSIFICATION SCHEME

1. THE GEOLOGIC ENVIRONMENT AND THE INFERRED GEOLOGIC PROCESSES DO NOT INDICATE FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

2. THE GEOLOGIC ENVIRONMENT AND THE INFERRED GEOLOGIC PROCESSES INDICATE LOW FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

3. THE GEOLOGIC ENVIRONMENT, THE INFERRED GEOLOGIC PROCESSES, AND THE REPORTED MINERAL OCCURRENCES INDICATE MODERATE FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

4. THE GEOLOGIC ENVIRONMENT, THE INFERRED GEOLOGIC PROCESSES, THE REPORTED MINERAL OCCURRENCES, AND THE KNOWN MINES OR DEPOSITS INDICATE HIGH FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

MAJOR STRATIGRAPHIC AND TIME DIVISIONS IN USE BY THE U.S. GEOLOGICAL SURVEY

Erathem or Era		System or Period	Series or Epoch	Estimated ages of time boundaries in millions of years
Cenozoic		Quaternary	Holocene	
			Pleistocene	2-3 [1]
		Tertiary	Pliocene	12 [1]
			Miocene	26 [2]
			Oligocene	37-38
			Eocene	53-54
			Paleocene	65
Mesozoic		Cretaceous [4]	Upper (Late) Lower (Early)	136
		Jurassic	Upper (Late) Middle (Middle) Lower (Early)	190-195
		Triassic	Upper (Late) Middle (Middle) Lower (Early)	225
Paleozoic		Permian [4]	Upper (Late) Lower (Early)	280
	Carboniferous Systems	Pennsylvanian [4]	Upper (Late) Middle (Middle) Lower (Early)	
		Mississippian [4]	Upper (Late) Lower (Early)	345
		Devonian	Upper (Late) Middle (Middle) Lower (Early)	395
		Silurian [4]	Upper (Late) Middle (Middle) Lower (Early)	430-440
		Ordovician [4]	Upper (Late) Middle (Middle) Lower (Early)	500
		Cambrian [4]	Upper (Late) Middle (Middle) Lower (Early)	570
Precambrian [4]			Informal subdivisions such as upper, middle, and lower, or upper and lower, or younger and older may be used locally.	3,600+ [3]

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[2] Geological Society of London, 1964, The Phanerozoic time-scale; a symposium: Geol. Soc. London, Quart. Jour., v. 120, supp., p. 260-262, for the Miocene through the Cambrian.

[3] Stern, T. W., written commun., 1968, for the Precambrian.

[4] Includes provincial series accepted for use in U.S. Geological Survey reports.

Terms designating time are in parentheses. Informal time terms early, middle, and late may be used for the eras, and for periods where there is no formal subdivision into Early, Middle, and Late, and for epochs. Informal rock terms lower, middle, and upper may be used where there is no formal subdivision of a system or of a series.

GEOLOGIC NAMES COMMITTEE, 1970